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AMERICAN SOCIETY

FOR

TESTING MATERIALS

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL MEETING

Held at Atlantic City, New Jersey
June 30—July 3, 1914

VOLUME XIV

PART I. COMMITTEE REPORTS

EDITED BY THE SECRETARY
UNDER THE REGULATIONS GOVERNING PUBLICATIONS

Office of the Secretary, University of Pennsylvania, Philadelphia, Pa.

PUBLISHED BY THE SOCIETY

1914

Entered according to Act of Congress by the
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SUMMARY OF THE PROCEEDINGS OF THE SEVENTEENTH ANNUAL MEETING.

Atlantic City, N. J., June 30–July 3, 1914.

The Seventeenth Annual Meeting of the American Society for Testing Materials was held at the Hotel Traymore, Atlantic City, N. J., on June 30–July 3, 1914. The attendance at the meeting was as follows: Members, 438 (including 24 companies, etc., whose representatives also hold membership in their own name); guests, 70; ladies, 115; total, 623. Deducting the 24 duplications above referred to, the actual personal attendance at the meeting was 599.

The following members were present or represented at the meeting:

A

Abraham, Herbert,
Ralph L. Shainwald, Jr.
Abrams, D. A.
Adams, H. C.,
W. H. Parish.
Aertsen, G.
Agg, T. R.
Aiken, W. A.
Ajax Metal Company,
G. H. Clamer.
Akin, Thomas B.
Allen, E. M.
Aluminate Patents Company,
E. L. Conwell.
American Brass Company,
W. H. Bassett.
American Bridge Company,
C. G. E. Larsson.
American Bureau of Shipping,
E. Platt Stratton.
American Electric Railway Engineering Association,
W. E. Johnson.
American Foundrymen's Association,
A. O. Backert.
American Locomotive Company,
S. V. Hunnings.
American Steel and Wire Company,
Edwin H. Peirce.
American Vulcanized Fibre Company,
Charles Almy, Jr.
Anderson, Louis, Jr.
Ashby, E. B.
Ashton, Ernest.
Associated Metal Lath Manufacturers,
H. B. McMaster.
Aupperle, J. A.

B

Babcock, G. C.
Backert, A. O.
(*The Iron Trade Review*).
Bacon, Charles V.
Baldwin Locomotive Works, The,
N. W. Sample, Jr.
Balz, George A.

Barbey, Jacob W.
Barbour, F. A.
Barrett Manufacturing Company,
W. S. Babcock.
Barrier, Edward A.
Bateman, Ernest.
Bates, P. H.
Bausch and Lomb Optical Company,
H. E. Howe.
Baxter, Florus R.
Beach, W. N.
Bergquist, J. G.
Berry, H. C.
Bethlehem Steel Company,
Charles E. Lehr.
Bierer, John M.
Bitting, A. W.
Bixby, W. H.
Blackmer, L. G.
Blair, Will P.
Blanchard, Arthur H.
Bleininger, A. V.
Boals, Ray B.
Bowen, Samuel B.,
L. Bowen.
Boyer, E. D.
Boynton, Henry C.
Bradley, J. H.
Bradley and Vrooman Company,
F. F. Bradley.
Brady, William.
Brass World and Platers' Guide,
Harry de Joannis.
Bridgeport Brass Company,
William Reuben Webster.
Brinton, F. H.
Brobston, Joseph.
Brooks, Benjamin.
Browne, D. B.
Brunner, John.
Buck, D. M.
Buffalo, Rochester and Pittsburgh Railway Company,
S. J. Wagar.
Bunnell, F. O.
Bureau of Construction and Repair, U. S. N.,
H. T. Wright.
Bureau of Steam Engineering, U. S. N., Naval Engineering Experiment Station,
G. S. Bryan.
Bureau of Steam Engineering, U. S N., Navy Department,
Gustav Kaemmerling.
Burrows, Charles W.
Butler, George.

C

Cain, John R.
Calumet Steel Company,
A. S. Hook.
Cambria Steel Company,
George E. Thackray.
Camden Forge Company,
W. D. Kerlin.
Campbell, William.
Capp, J. A.
Carleton, Guy E.
Carnahan, R. B., Jr.
Carnegie Steel Company,
C. F. W. Rys.
Carpenter Steel Company, The,
J. H. Parker.
Carroll, Walter C.
Central Iron and Steel Company,
Robert H. Irons.
Chamberlain, O. P.
Charls, G. H.
Chatburn, George R.
Cheesman, Frank P.
Christie, Alexander J.
Church, S. R.
Churchill, Charles S.
Claiborne, Charles H.
Clark, F. H.
Cobb, Ernest B.
Coe, Robert.
Cohen, A. B.
Colby, J. A.
Colorado Fuel and Iron Company,
Jacob Cambier.
Columbia Steel and Shafting Company,
Edward L. Parker.

Conn, Charles F.
Conradson, P. H.
Consolidated Rosendale Cement Company,
William C. Morton.
Cook, Oscar U.
Cooper, William A.
Corse, W. M.
Cowan, William A.
Crawford, C. H.
Crawford, J. Craig.
Crescent Portland Cement Company,
Otto C. Hasse.
Cromwell, O. C.
Crume, W. H.
Cushing, W. C.
Cushman, Allerton S.

D

Dannerth, Frederic.
Davies, George C.
De Knight, Edward W.
Devries, Ralph P.
Dickinson, H. C.
Diekmann, George P.
Diller, H. E.
Dixon Crucible Company, Joseph,
Malcolm McNaughton.
Dow, Allan W.
Drew, Harry.
Driggs, L. L.
DuComb, W. C., Jr.
Dunbar, W. O.
Dunn, B. W.

E

Edwards, L. N.
Emley, Warren E.
Engineering Record,
E. J. Mehren.
Enright, Bernard.

F

Ferguson, Lewis R.
Fibre Shipping Container Association,
Thomas W. Ross.
Fieldner, A. C.
Fireman, Peter.
Fleming, William R.
Flowers, Alan E.
Force, H. J.
Ford, Allen P.
Forrest, C. N.
Fort, Edwin J.
Fowler, George L.
(*Railway Age Gazette*).
Franklin Steel Company,
Edward E. Hughes.
French, J. Hansell.
Froehling and Robertson,
Henry C. Froehling.
Fuller, Almon H.
Fulweiler, W. Herbert.

G

Gardner, Henry A.
Geer, William C.,
N. S. Noble.
Geiser, W. B.
General Electric Company,
J. A. Capp.
General Electric Company, Lynn Works,
E. Weintraub.
General Motors Company,
K. W. Zimmerschied.
Geological Survey of New Jersey,
R. B. Gage.
Gibboney, James H.
Gibbs, A. W.
Glasgow Iron Company,
James P. Roe.
Goldbeck, Albert T.
Goodrich Company, The B. F.,
N. S. Noble.
Goodspeed, G. M.
Graf, S. H.
Gray, Thomas T.
Greene, Hermann L.
Greenman, Russel S.
Greenwald, Harry.
Griffith, R. E.

Grindlay, L. B.
Gulick, Henry, Jr.
Gutta Percha and Rubber Manufacturing Company, The,
W. E. Campbell.
Gypsum Industries Association,
S. G. Webb

H

Hall, Ellis B.
Harding, W. H.
Harrington, C. O., Jr.
Hatt, William K.
Heckel, G. B.
(*Drugs, Oils and Paints*).
Hemstreet, George P.
Henry, John A.
Hering, Rudolph.
Hess, Henry.
Hibbard, Henry D.
Hillebrand, W. F.
Hopkins, George A.
Howe, Henry M.
Hoxie, F. J.
Hubbard, Prévost.
Huber, Frederick W.
Hummelstown Brown Stone Company,
S. O. Goho.
Humphrey, Richard L.
Hunnings, S. V.
Hunt and Company, Robert W.,
Robert W. Hunt.

I

Ickes, Elwood T.
Illinois Steel Company,
P. E. Carhart.
Ingalls, F. P.
Iron Age, The,
Edwin F. Cone.

J

Jacoby, Henry S.
Jeffers, John M.
Jennison, H. C.
Job, Robert.
Johnsen, Arthur M.
Johnson, J. E., Jr.
Jones, Jesse L.
Jones, Jonathan.
Jones and Laughlin Steel Company
Jesse J. Shuman.
Joseph, J. G.,
W. H. Woodcock.

K

Kaiser, Frank H.
Kanolt, C. W.
Kelley, F. W.
Kelsey, Victor V.
Kenney, E. F.
Kerr, C. H.
Ketchum, Milo S.
Keystone Fireproofing Company,
S. G. Webb.
Kinney, William M.
Koch, George B.
Kohr, D. A.

L

Lackawanna Steel Company,
F. E. Abbott.
Laclede-Christy Clay Products Company,
R. D. Hatton.
Lanza, Gaetano.
Larsson, C. G. E.
Lawson, Thomas R.
Leech, J. O.
Leeds and Northrup Company, The
C. R. Cary.
Lehigh Valley Railroad Company,
E. B. Ashby.
Lenhart, James M.
Lesley, Robert W.
Linder, Oscar.
Lindsay, R. W.
Little, Incorporated, A. D.,
C. F. Woods.
Lober, J. B.
Lothrop, M. T.

Lovell, Alfred.
Lowe Brothers Company, The,
John G. Lowe.
Lucas, George L.
Lucas and Company, John,
Leo P. Nemzek.
Lukens Iron and Steel Company,
Charles L. Huston.
Lumen Bearing Company,
N. K. B. Patch.
Lunn, Charles A.
Lynch, T. D.

M

MacFarland, H. B.
Macgregor, James S.
MacGregor, John R.
Mackenzie, K. G.
MacPherran, R. S.
Maitland, Harold T.
Marburg, Edgar.
Marsh, C. P.
Marshall, S. M.
Marston, A.
Masters, Frank M.
Masury and Son, John W.,
F. P. Ingalls.
Mathews, John A.
Mattimore, H. S.
McDonnell, M. E.
McIlhiney, Parker C.
McMaster, H. B.
McNaugher, D. W.
Meade, Richard K.
Metal Industry, The,
L. J. Krom.
Midvale Steel Company,
G. Aersten.
Miller, Rudolph P.
Miner, Joshua L.
Moisseff, Leon S.
Moldenke, Richard.
Moore, H. A.
Moyer, Albert.
Muckenfuss, A. M.
Myers, J. E.

N

National Tube Company,
Frank N. Speller.
Neal, C. S.
Neale, Laurence I.
New England Box Company, The,
W. E. Stratton.
New Jersey Zinc Company,
Gilbert Rigg.
New York Central and Hudson River Railroad Company,
Eng. Dept.,
A. W. Carpenter.
Newport News Shipbuilding and Dry Dock Company,
John W. Gray.
Newlin, J. A.
Norris, George L.
Norton, Charles L.

O

Ogden, Benjamin.
Olsen, Thorsten Y.
Olsen, Tinius.
Onderdonk, J. R.
Orton, Edward, Jr.

P

Page, Logan Waller.
Paisley, John W.
Paragon Plaster Company,
W. K. Squier.
Parmelee, Cullen W.
Parr, S. W.
Pease, Burton H.
Peirce, Edwin H.
Pennsylvania State Highway Department,
Joseph W. Hunter.
Perfection Spring Company,
Z. B. Leonard.
Petinot, N. G.
Phillips, W. H.
Pickard, Glenn H.

Pierce Arrow Motor Car Company,
Robert W. Appleton.
Pittsburgh Testing Laboratory,
J. O. Handy.
Plumb, R. Alfred,
Frederick Pinkham.
Polk, Anderson.
Pollak, Julian A.
Pope, George S.
Porter, Horace C.
Porter, J. Madison.
Potts, Stephen C.
Pressed Steel Car Company,
H. J. Gearhart.
Price, William B.
Provost, Andrew J., Jr.

Q

Quimby, H. H.

R

Ramage, J. C.
Randall, Theodore A.
(*Clay Worker*).
Rathjens, George.
Ray, George J.
Raymond Concrete Pile Company,
Nathan C. Johnson.
Reeve, C. S.
Reinhardt, G. A.
Remington Arms and Ammunition Company,
Nathan A. Chase.
Reninger, Henry A.
Republic Iron and Steel Company,
L. B. Grindlay.
Rhode Island Tool Company,
Arthur H. Annan.
Rich, Charles H.
Richardson, Clifford.
Riehlé, Frederick A.,
F. Buckingham.
Rigg, Gilbert.
Rinald, C. D.
Robinson, A. F.
Robinson, Samuel R.
Rodgers, S. M.
Roebling's Sons Company, John A.,
H. J. Horn.
Rogers, Allen.
Rogers, R. E.
Royle and Sons, John,
Vernon E. Royle.
Rys, C. F. W.

S

Sabin, A. H.
Sauveur, Albert.
Savage, H. D.
Schaeffer, John A.
Schaffer, H. A.
Schall, F. E.
Schmitt, F. E.
(*Engineering News*).
Seaman, Harry J.
Seaton, M. Y.
Seaver, Kenneth.
Sharples, Philip P.
Shelley, Henry T.
Shipley, Grant B.
Shuman, Jesse J.
Skinner, C. E.
Slocum, Frank S.
Smith, E. B.
Smith, F. P.
Smith, H. E.
Snow, J. P.
Spackman Engineering Company, Henry S.,
W. A. Aiken.
Spalding, F. P.
Spencer, Herbert.
Stafford, Samuel G.
Standard Screw Company,
E. H. Ehrman.
Standard Steel Works Company,
A. A. Stevenson.
Starr, John J.
Stevenson, A. A.
Stimson, Earl,
F. F. Hanly.

Stone, George C.
Stoughton, Bradley.
Stull, R. T.
Sturcke, H. E.
Swain, George F.
Swan, O. T.
Swett, Bertram L.

T

Taber, George H.
Tagliabue, C. J.
Talbot, Arthur N.
Taylor, C. Marshall.
Taylor, Knox.
Taylor Instrument Companies,
Edward N. Hurlburt.
Testing Laboratory, City of St. Louis,
Mont Schuyler.
Thompson, Gustave W.
Thompson, Sanford E.
Tiemann, Hugh P.
Tilt, Edwin B.
Titanium-Alloy Manufacturing Company, The,
William F. Meredith.
Topping, W. S.
Trautwine, John C., Jr.
Tretch, William J.

U

Uhler, J. Lloyd.
Unger, J. S.
United Gas Improvement Company,
W. Herbert Fulweiler.
United States Asphalt Refining Company,
Leroy M. Law.
United States Gutta Percha Paint Company,
Herbert W. Rice.
United States Gypsum Company,
Virgil G. Marani.

V

Van Gundy, C. P.
Veitch, F. P.
Victor Talking Machine Company,
Edwin F. Hicks.
Von Schrenk, Hermann.
Voorhees, S. S.
Vredenburgh, Watson, Jr.

W

Wagner, Samuel Tobias.
Waldo, Leonard.
Walker, Percy H.
Walker, William H.
Walter, L. W.
Ware, E. E.
Waring, F. M.
Warner, Charles.
Warwick, C. Laurence.
Washburn, W. F.
Webbert, Louis P.
Webster, George S.
Webster, William Reuben.
Weiss, John Morris.
West, Thomas D.
West Virginia University Library,
W. E. Dickinson.
Western Electric Company,
C. R. Myer.
Westinghouse Air Brake Company,
Harry C. Loudenbeck.
Westinghouse, Church, Kerr and Company,
Cloyd M. Chapman.
Westinghouse Electric and Manufacturing Company,
T. D. Lynch.
Westinghouse Machine Company,
J. Mason Ormsbee.
White, Alfred H.
White, G. D.
Wickhorst, Max H.
Wig, Rudolph J.
Wiley, W. O.

Wilhelm Company, The A.,
Walter S. Davis.
Wille, H. V.
N. W. Sample, Jr.
Wilson, Edwards F.
Wilson, John J.
Wilson, Percy H.
Winchester Repeating Arms Company,
R. L. Penney.
Wood, Edwin T.
Wood, Walter.
Wood and Company, R. D.,
Walter Wood.
Wood Iron and Steel Company, Alan,
Charles H. Rich.
Woolson, Ira H.
Worth Brothers Company,
James L. Hughes.

Y

Yellow Pine Manufacturers' Association,
J. W. Martin.
York Manufacturing Company,
Charles H. Ehrenfeld.
Young, C. D.
Young, J. Bertram.
Youngman, R. H.
Youngstown Sheet and Tube Company,
E. T. McCleary.

Z

Zeigler, S. J., Jr.
Zeleny, Frank.
Zimmerschied, K. W.

FIRST SESSION.—TUESDAY, JUNE 30, 11 A. M.

President A. N. Talbot in the chair.

The minutes of the Sixteenth Annual Meeting were approved as printed.

The Secretary-Treasurer presented the annual report of the Executive Committee. The Chair announced that action on the proposed amendments of the by-laws would be deferred till towards the end of the session.

The Chair appointed Mr. J. B. Young and Mr. Frank Zeleny as tellers of the vote on the election of officers.

In the absence of Mr. I. H. Woolson, Chairman of Committee C-5 on Fireproofing Materials, the report of that committee was read by title.

The report of Committee D-11 on Standard Specifications for Rubber Products was presented by Mr. E. B. Tilt, Chairman.

After the discussion of this report the following papers were presented by their authors and discussed:

"Rubber Belting and Methods of Testing," by Mr. W. E. Campbell.

"An Autographic Friction Testing Machine for Testing Mechanical Rubber Goods," by Mr. J. M. Bierer.

The reports of Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, and of Committee E-6 on Papers and Publications, were presented by Mr. Edgar Marburg, Chairman of these committees.

The report of the tellers was then presented, to the effect that the total number of legal ballots cast was 394, and in accordance with their report the Chair declared the election of Mr. A. W. Gibbs, President; Mr. A. A. Stevenson, Second Vice-President; Mr. Edgar Marburg, Secretary-Treasurer; and Messrs. Robert Job, F. W. Kelley, A. Marston and S. S. Voorhees, Members of Executive Committee.

The proposed amendments of the by-laws recommended by the Executive Committee were then submitted.

On motion of Mr. J. A. Capp, the by-laws as amended were referred to letter ballot of the Society.

The meeting then adjourned till 3 p. m.

SECOND SESSION.—TUESDAY, JUNE 30, 3 P. M.

On Non-Ferrous Metals.

President A. N. Talbot in the chair.

The report of Committee B-1 on Standard Specifications for Copper Wire was presented by Mr. J. A. Capp, Chairman.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was then introduced by Mr. William Campbell, Chairman.

On motion of Mr. G. H. Clamer, the proposed revisions in the Standard Specifications for (1) Spelter, and (2) Manganese-Bronze Ingots were referred to letter ballot of the Society.

The following papers were then presented by their respective authors and discussed:

"A Rational Test for Metallic Protective Coatings," by Mr. J. A. Capp.

"Method of Sampling and Analysis of Tin, Terne and Lead-Coated Sheets," by Mr. J. A. Aupperle.

"Considerations Affecting Specifications for Wrought Non-Ferrous Materials," by Mr. William Reuben Webster.

"Study of the Strength of Non-Ferrous Castings: Comparison of Different Test Specimens," by Mr. L. P. Webbert.

The meeting then adjourned till 8 p. m.

THIRD SESSION.—TUESDAY, JUNE 30, 8 P. M.

President-elect A. W. Gibbs in the chair.

The Presidential Address entitled "The Relation Between Research and the Activities of the Society," was delivered by the retiring President, Mr. A. N. Talbot.

Mr. Henry M. Howe, Life Member of the Council of the International Association for Testing Materials, presented a report of the proceedings of the Turin meeting of the Council of that association.

A paper entitled "Are the Effects of Simple Overstrain Monotropic?" was then presented by its author, Mr. Henry M. Howe, and discussed.

A paper on "Hardness Tests: Relation between Brinell Ball-Test and Sclerescope Readings," by Capt. J. J. Thomas, was, in the absence of the author, read by title.

A paper entitled "A Critical Review of the Procedure Governing the Adoption of Standards" was introduced by its author, Mr. Edgar Marburg, and discussed.

The meeting then adjourned till the following morning.

FOURTH SESSION.—WEDNESDAY, JULY 1, 10 A. M.

On Steel.

Past-President Robert W. Hunt in the chair.

In the absence of Mr. C. D. Young, Chairman of Committee A-1 on Standard Specifications for Steel, the report of that committee was introduced by its Vice-Chairman, Mr. J. A. Capp.

Mr. Capp presented the following recommendations in modification of the printed report and in pursuance of action

to that effect at a meeting of Committee A-1 held on the evening of June 29, attended by 45 members.

Proposed Revised Standard Specifications for Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars.—Committee A-1, by unanimous vote, recommends that these proposed revised specifications be amended by the insertion of the following new Section 1 under the heading "Basis of Purchase," existing section numbers being changed accordingly:

> "When used for forgings for locomotives, these specifications cover quenched-and-tempered carbon-steel driving axles, engine and trailing-truck axles, main and side rods, straps, crank pins and piston rods."

Proposed Revised Standard Specifications for Carbon-Steel Forgings for Locomotives.—Committee A-1, by a vote of 30 affirmative, none negative, and 15 not voting, recommends that these proposed revised specifications be amended by the insertion, in the table in Section 9 (*a*) covering untreated forgings, of the class by size of "Over 8 to 12 in., inclusive," the tensile properties to be the same as those of the corresponding class by size of Class D Untreated Forgings in the proposed revised Standard Specifications for Carbon-Steel and Alloy-Steel Forgings.

Proposed New Standard Specifications for Carbon-Steel Bars for Springs.—Committee A-1, by a vote of 28 affirmative, none negative, and 17 not voting, recommends that these proposed new specifications be amended to apply only to railway springs by making the following changes:

(*a*) Insert "railway" between "for" and "springs" in the title;

(*b*) In Section 1 (*a*), line 1, change "three" to "two";

(*c*) In Section 1 (*b*), strike out "Class A, for automobile and vehicle springs;" change "Class B" to "Class A," striking out the words "automobile and railway;" change "Class C" to "Class B," striking out the word "railway;"

(*d*) In Section 3, omit Class A, and change Classes B and C to A and B, respectively;

with the understanding that the question of specifications for carbon-steel bars for automobile springs will be referred back to Sub-Committee IV on Spring Steel for report during the coming year.

The report of Committee A-1, as thus amended, was then considered item for item and passed to letter ballot of the Society.

In connection with the consideration of the proposed revised Standard Specifications for Quenched-and-Tempered Carbon-Steel Axles, Shafts and other Forgings for Locomotives and Cars, a minority report on behalf of certain representatives of the American Electric Railway Engineering Association was presented, and a motion by Mr. W. E. Johnson that the title of these specifications be changed to the following form: "Standard Specifications for Quenched-and-Tempered Carbon-Steel Axles, Shafts, and other Forgings for Locomotives and Trailer Axles for Cars," was lost.

In accordance with the foregoing action the following matters were referred to letter ballot of the Society:

PROPOSED NEW STANDARDS:

Specifications for Structural Steel for Cars.
Specifications for Carbon-Steel Bars for Railway Springs.
Methods of Chemical Analysis for Plain Carbon Steel.

PROPOSED REVISIONS IN STANDARD SPECIFICATIONS:

For Bessemer Steel Rails.
For Open-Hearth Steel Rails.
For Low-Carbon-Steel Splice Bars.
For Medium-Carbon-Steel Splice Bars.
For High-Carbon-Steel Splice Bars.
For Extra-High-Carbon-Steel Splice Bars.
For Structural Steel for Bridges.
For Structural Nickel Steel.
For Structural Steel for Buildings.
For Shapes, Universal Mill Plates and Bars for Locomotive Materials.

For Billet-Steel Concrete Reinforcement Bars.
For Steel Forgings.
For Heat-Treated Carbon-Steel Axles, Shafts, and Similar Objects.
For Steel Forgings for Locomotives.
For Carbon-Steel Car and Tender Axles.
For Cold-Rolled Steel Axles.

On motion of Mr. Capp, the recommendations as to the position of fracture of 2 and 8-in. tension test specimens, embodied in the report of Committee A-1, were referred to letter ballot of the Society.

On motion of Mr. Capp, it was decided that the factor table and curve for values of elongation and reduction of area, shown in Appendix III of the report of Committee A-1, shall be printed in the Year-Book and also as a separate reprint.

On motion of Mr. Capp, the recommendation of the committee that certain specifications designated in its report shall be classed as applicable to locomotives and so indexed in the table of contents of the Year-Book of the Society, was approved, as well as the further recommendation that the title "Standard Specifications for Locomotive Materials" be hereafter omitted.

The report of Committee A-4 on Heat-Treatment of Iron and Steel was presented by Mr. Albert Sauveur, Chairman.

On motion of Mr. Sauveur the following proposed Recommended Practice for (*a*) The Annealing of Carbon-Steel Castings, and (*b*) The Heat Treatment of Case-Hardened Carbon-Steel Objects, were referred to letter ballot of the Society.

The report of Committee A-8 on Standard Specifications for Cold-Drawn Steel was presented by Mr. C. E. Skinner, Chairman.

On motion of Mr. Skinner, the proposed Standard Specifications for Cold-Drawn Steel: Bessemer Automatic Screw Stock, were referred to letter ballot of the Society; and the Specifications for Cold-Drawn Steel: Open-hearth Screw Stock, proposed tentatively, were ordered printed in the Year-Book.

The report of Committee A-6 on Magnetic Testing of Iron and Steel was presented by the Chairman, Mr. Charles W. Burrows.

On motion of Mr. Burrows the modifications in the Standard Magnetic Tests of Iron and Steel, recommended by Committee A-6, were referred to letter ballot of the Society.

The following papers were then presented by their respective authors and discussed:

"Magnetic Habits of Alloy Steels," by Mr. J. A. Mathews.

"A Failed Axle: Study of an Internal Transverse Fissure," by Mr. Robert Job.

The meeting then adjourned till 8 p. m.

FIFTH SESSION.—WEDNESDAY, JULY 1, 3 P. M.

President A. N. Talbot in the chair.

The report of Committee A-3 on Standard Specifications for Cast Iron and Finished Castings was presented by Mr. Richard Moldenke, Chairman.

Mr. Moldenke moved on behalf of Committee A-3 that the following sentence be added at the end of Section 6 (*a*) of the proposed revised Standard Specifications for Locomotive Cylinders: "It shall not be rumbled or otherwise treated, being simply brushed off before testing;" and that the specifications, as thus amended, be referred to letter ballot of the Society.

This motion was seconded and carried.

On the invitation of the Chair, Vice-President Richard Moldenke then took the chair.

A paper entitled "Notes on Chilled Cast Iron" was presented by its author, Mr. E. B. Tilt, and discussed.

The report of Committee A-2 on Standard Specifications for Wrought Iron was presented by Mr. S. V. Hunnings, Chairman.

On motion of Mr. Hunnings, the proposed revision of the Standard Specifications for Staybolt Iron was referred to letter ballot of the Society.

A paper on "A New Vibratory Testing Machine and Results Obtained by Its Use" was presented by its author, Mr. S. V. Hunnings.

The report of Committee D-7 on Standard Specifications for Timber was introduced by Mr. Hermann von Schrenk, Chairman.

The report of Committee E-4 on Methods of Sampling and Analysis of Coal was presented by Mr. S. W. Parr, Chairman.

The meeting then adjourned till the following morning.

SIXTH SESSION.—THURSDAY, JULY 2, 10 A. M.

On Cement and Concrete.

President A. N. Talbot in the chair.

The report of Committee C-1 on Standard Specifications for Cement was presented by Mr. George F. Swain, Chairman.

On motion of Mr. Richard L. Humphrey the question of the appointment of a joint committee on a standard screen scale, consisting of sub-committees of this and other societies, was referred to the Executive Committee.

The following papers were then presented by their respective authors and discussed:

"Proportioning Aggregates for Portland-Cement Concrete," by Mr. Albert Moyer.

"Testing Concrete Aggregates," by Mr. Cloyd M. Chapman.

"Blast-Furnace Slag as Aggregate in Concrete," by Mr. W. A. Aiken.

"Additional Results Obtained with the Autoclave Test for Portland Cement," by Mr. H. J. Force.

"Examination of Concrete Failures for Their Determining Causes," by Mr. R. S. Greenman.

A paper on "Errors in the Methods of Determining the Time of Setting of Cement," by Mr. G. M. Williams, was, in the absence of the author, introduced by Mr. R. J. Wig and discussed.

A paper by Mr. G. A. Maney on "Relation between Deformation and Deflection in Reinforced-Concrete Beams" was, in the absence of the author, read by title.

A paper on "Volume Changes of Portland Cement and Concrete" was presented by its author, Mr. A. H. White, and discussed.

A paper on "The Use of Turned Sections in Tension Tests of Reinforcing Bars," by Mr. E. P. Withrow and Mr. L. C.

Niedner, was, in the absence of the authors, presented by Mr. Mont Schuyler and discussed.

The Secretary announced on behalf of the Executive Committee the offer by Sir Robert Hadfield of a one thousand dollar Hadfield Research Prize for the best contribution to the publications of the American Institute of Mining Engineers on "The Different Forms and Combinations of Carbon with Iron Including those in Iron Alloys," and that only papers presented before November 1, 1915, would be considered in that connection, the formal award of the prize being scheduled for the annual meeting of the Institute in New York in February, 1916.

The meeting then adjourned till 3 p. m.

SEVENTH SESSION.—THURSDAY, JULY 2, 3 P. M.

On Lime, Ceramics and Road Materials.

Mr. W. K. Hatt in the chair.

The report of Committee C-7 on Standard Specifications for Lime was presented by Mr. J. S. Macgregor, Chairman, who recommended, on behalf of the committee and in pursuance of action taken at a meeting held on July 1, numerous changes in the proposed Standard Specifications for Quicklime and for Hydrated Lime and the withdrawal of the recommendation that they be referred to letter ballot of the Society, recommending instead that they be printed as tentative specifications.

Mr. W. A. Aiken moved that the proposed specifications, as thus revised, be printed as tentative specifications both in the Proceedings and in the Year-Book.

Mr. Edgar Marburg proposed an amendment to this motion to the effect that the specifications be printed for the ensuing year in the Proceedings and that their publication in the Year-Book be left to the judgment of the Executive Committee. This amendment was accepted by Mr. Aiken and the motion as amended was adopted.

A paper on "A Machine for Testing Clay Products" was presented by its author, Mr. Mont Schuyler, and discussed.

The report of Committee D-4 on Standard Tests for Road

Materials was then introduced by Mr. Prévost Hubbard, Secretary of the committee.

Mr. Hubbard moved that the proposed Definitions of Bituminous and Non-Bituminous Road Materials be printed in the Proceedings for one year. This motion was adopted.

Mr. Hubbard moved that the proposed Provisional Test for the Determination of the Apparent Specific Gravity of Rock be referred to letter ballot of the Society.

Mr. Richard L. Humphrey offered an amendment to this motion by which this proposed provisional test should be referred to a conference of sub-committees from this and other technical committees of the Society.

This amendment was accepted by Mr. Hubbard in its bearing both on the provisional test in question and the other provisional tests and methods appended to the report of Committee D-4.

The motion as thus extended and amended was adopted.

Mr. Hubbard moved that the proposed Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements, which had been printed in Vol. XIII of the Proceedings, be referred to letter ballot of the Society.

Mr. W. A. Aiken moved that action on these definitions be deferred pending a conference between sub-committees of Committee D-4 on Standard Tests for Road Materials and Committee D-8 on Waterproofing Materials.

This amendment was accepted by Mr. Hubbard and the motion as thus amended was adopted.

Mr. Humphrey moved that a sub-committee of Committee C-2 on Reinforced Concrete be also included in the proposed conference, but consented to an amendment of this motion by which the determination of the committee to which these proposed definitions shall be referred was left to the Executive Committee.

The motion as thus amended was adopted.

A paper on the "Strength of Lime Mortar," by Mr. W. E. Emley and Mr. S. E. Young, was then introduced by Mr. Emley.

The report of Committee C-3 on Standard Specifications for Brick was presented by Mr. A. V. Bleininger, Chairman.

Mr. A. H. Blanchard moved that the proposed Standard Specifications for Paving Brick be referred to a conference of Committee C-3 on Standard Specifications for Brick and Committee D-4 on Standard Tests for Road Materials.

This motion was lost.

The report of Committee C-4 on Standard Specifications and Tests for Clay and Cement Sewer Pipes was presented by Mr. Rudolph Hering, Chairman.

The report of Committee C-6 on Standard Tests and Specifications for Drain Tile was presented by Mr. A. Marston, Chairman.

On motion of Mr. Marston, the proposed Standard Specifications for (*a*) Strength Tests of Drain Tile, and (*b*) Quality of Drain Tile, and the proposed Recommended Practice in Design and Construction of Tile Drain, were referred to letter ballot of the Society.

A paper on "Methods for Determining the Melting Points of Asphalts," by Mr. J. G. Miller and Mr. P. P. Sharples, was presented by Mr. Sharples.

The meeting then adjourned till the following morning.

EIGHTH SESSION.—FRIDAY, JULY 3, 10 A. M.

On Preservative Coatings.

President-elect A. W. Gibbs in the chair.

The following resolutions, introduced by the Secretary, were, on motion, approved:

"*Whereas*, In the report of Committee C-6 on Standard Tests and Specifications for Drain Tile, presented at this meeting, it is stated in substance that "Satisfactory and definite specifications for quality of tile" require (*a*) Standard Specifications for Strength Tests and (*b*) the Definition of Practice in Tile Drain Design and Construction, and

"*Whereas*, The proposed standards and practice embodied in the report of Committee C-6 were referred without debate to letter ballot of the Society, and

"*Whereas*, This is the first instance in which proposed standard specifications of the Society are based on prescribed engineering design and construction, and

"*Whereas*, It is the sense of this meeting that matters of engineering design and construction do not, in general, properly fall within the province of the Society, be it therefore

"*Resolved*, (*a*) That the Executive Committee be hereby instructed to consider the general questions involved in such a departure from the previous policy of the Society, and (*b*) that the Executive Committee and Committee C-6 be jointly instructed to consider the particular questions involved in this instance, and that the findings be reported to the Society at the next annual meeting."

The report of Committee D-1 on Preservative Coatings for Structural Materials was presented by Mr. P. H. Walker, Chairman, who recommended on behalf of that committee the following amendments in that report, which he stated had been unanimously agreed to by those members of the committee present at a meeting held on the evening of July 2:

On page 2, after line 19, insert: "Sub-Committee V on Linseed Oil."

On page 2, after line 32, strike out: "Sub-Committee V on Linseed Oil (a short report is, however, presented herewith)."

On page 3, insert the following "Addendum":

"At a meeting held at Atlantic City, July 2, 1914, at which 32 members were present, it was decided to discontinue inspection of the Havre de Grace bridge tests and Sub-Committee II was instructed to dispose of the plates, giving one set to the Bureau of Standards, one set to the Institute of Industrial Research, and making such disposition of the third set as the sub-committee saw fit.

"It was decided that no further inspection be made of the Atlantic City steel test fence, and Sub-Committee IV on Inspection of Steel Plates at Atlantic City was directed to prepare a report on the relation of the results obtained

from the inspections of the Atlantic City test fence and the water test on which they were based, such report to be in the hands of the Secretary of Committee D-1 so that a copy can be sent to each member of the committee prior to the November meeting."

After page 41, insert as an appendix to Report of Sub-Committee V on Linseed Oil, the paper by Bearce and Peffer on the Density and Thermal Expansion of Linseed Oil.

On page 107, after line 8, insert: "There are attached hereto specifications for turpentine which are tentative and not offered for adoption by the Society."

On page 119, after the word "past," line 3, insert: "Both of these methods are arbitrary ones used for convenience and speed, but not necessarily giving accurate percentages of rosin and insoluble matter."

Mr. Walker moved that the proposed Standard Definitions of Terms used in Paint Specifications, embodied in the report of the committee, which definitions had previously been published in the Proceedings of the Society as prescribed by the regulations, be referred to letter ballot.

This motion was seconded and carried.

In pursuance of objections on the part of Mr. C. D. Rinald, this motion was reconsidered.

Mr. Rinald then presented a list of definitions which he recommended for substitution for those offered by the committee.

After considerable discussion the vote to refer the proposed standard definitions offered by Committee D-1 to letter ballot of the Society, and to refer the amendments proposed by Mr. Rinald to the committee for further consideration, was lost.

A motion by Mr. F. P. Cheesman that these proposed standard definitions be referred back to the committee for further consideration was adopted.

Mr. Walker moved that the report of the committee as printed, including the proposed amendments, be accepted and printed in the Proceedings. This motion was seconded and adopted.

Mr. A. W. Carpenter moved that Committee D-1 be instructed to prepare and present a complete report on the Havre de Grace paint tests in which the nature of the coatings are to be stated in terms intelligible to engineers, and in which the conditions under which the tests were conducted are to be briefly described.

Mr. Edgar Marburg moved as an amendment to this motion that Committee D-1 be charged to renew its efforts in the directions indicated in Mr. Carpenter's motion and to present a report next year on the results of such renewed efforts.

This amendment was accepted and the motion as amended was carried.

Mr. H. A. Gardner then presented a paper on "Paint Protection for Portland-Cement Surfaces."

A "Report on a Permeability Test for Paints and Varnishes," by Mr. A. M. Muckenfuss, was followed by a general discussion on "The Permeability and Porosity of Preservative Coatings."

In the absence of the author the paper on "Quantitive Determination of Body and Solvent in Varnish," by Mr. A. L. Brown, was presented by title.

A paper on "Examination of Chinese Wood Oil," by Mr. E. E. Ware and Mr. C. L. Schumann, was introduced by Mr. Ware.

A paper on "Specifications and Tests of Glue," by Mr. O. Linder and Mr. E. C. Frost, was, in the absence of the authors, read by title.

The meeting then adjourned till 3 p. m.

NINTH SESSION.—FRIDAY, JULY 3, 3 P. M.

On Testing Apparatus and Methods.

President A. N. Talbot in the chair.

The report of Committee E-1 on Standard Methods of Testing was presented by Mr. Gaetano Lanza, Chairman.

Mr. Lanza reported that at a meeting of Committee E-1 held on July 1, the following action had been taken by the

eleven members of the committee in attendance at the annual meeting, out of the total membership of the committee of 19:

1. Regarding the recommendations made concerning the Brinell test:

Resolved, That, in the opinion of the members present, the various recommendations concerning the Brinell tests represent prospective refinements and improvements to be considered in the future reports of the committee, rather than as appropriate for incorporation into our present report, or as justification for delaying the adoption of the report of the committee.

2. Regarding the criticisms on the standard methods of measurement:

The members present recommend that the following sentence be added to paragraph 6, page 3, of the report: "There is no intention to abolish the use of any extensometer whether it has two or three-point contact, but only to furnish a standard by which the efficiency of any extensometer can be gaged."

3. Regarding the definitions of proportional limit, elastic limit, and yield point:

Resolved, That these definitions are in accord with the best custom of the present day, the first and second agreeing with international usage, and the third with that of the British Standards Committee.

4. Regarding the criticism on the gage length of specimens in the case of material $\frac{1}{4}$ in. or under in thickness:

The members present recommend that to paragraph 2, page 3, of the report there be added the following clause: "except that in no case shall the gage length be less than 2 in."

After a discussion both verbally and by letter, Mr. Edgar Marburg moved that the report of the committee be published in the Proceedings and that the membership of the Society at large be invited to send written criticisms of the report to the committee in order that the committee may take these under

consideration in the presentation of their annual report a year hence.

Instead of applying this motion to the report as a whole, the six recommendations contained therein were considered separately and the motion was applied to each in turn, the vote being affirmative throughout.

Mr. F. Buckingham suggested the desirability of further consideration on the part of Committee E-1 of the provisions affecting the calibration of testing machines in the present Standard Methods of Testing.

Mr. Lanza gave assurances that the committee would gladly give attention to this matter.

The report of Committee D-2 on Standard Tests for Lubricants was presented, in the absence of the Chairman, Mr. A. H. Gill, by Mr. P. H. Conradson.

Mr. C. D. Young moved the insertion of the minority report as to "Viscosity" at the end of the section on "Viscosity" in the majority report.

After discussion, Mr. Young withdrew this motion in favor of a motion by Mr. Edgar Marburg to the effect that both the majority and minority reports be printed in the Proceedings and that the committee be instructed to give further consideration to the question at issue. This motion was adopted.

A paper on "Viscosity Measurement and a New Viscosimeter" was then presented by its author, Mr. Alan E. Flowers.

The following papers were, in the absence of their authors, presented by title:

"An Improved Type of Axial Strainometer," by Mr. Arthur C. Alvarez.

"A Simple Compression Machine for Testing Structural Materials," by Mr. William O. Lichtner.

A paper on "An Efficiency Testing Machine for Testing Drills, Taps and Dies" was then introduced by its author, Mr. T. Y. Olsen.

On motion of the Secretary, a resolution was passed, by unanimous vote, expressive of the thanks of the meeting to the Bausch and Lomb Optical Co., and to their representative, Mr. H. E. Howe, for the service rendered the Society by the excellent provision for the illustration of papers.

Mr. A. N. Talbot expressed his appreciation, as the retiring President, of the honor conferred upon him by the Society in his election to the Presidency a year ago, congratulated the Society on the election of Mr. A. W. Gibbs as his successor, and formally relinquished the chair to Mr. Gibbs.

The President-elect, Mr. A. W. Gibbs, made some commendatory remarks on the administration of President Talbot and pledged his best efforts in his prospective discharge of the duties of the President for the ensuing term.

The Chair then declared the meeting adjourned *sine die.*

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROCEEDINGS.

The Society is not responsible, as a body, for the statements and opinions advanced in its publications.

THE RELATION BETWEEN RESEARCH AND THE ACTIVITIES OF THE SOCIETY.

ANNUAL ADDRESS BY THE PRESIDENT, ARTHUR N. TALBOT.

The American Society for Testing Materials, in its sixteen years of activity, has had to do with the methods of testing engineering materials,—standardizing methods to produce uniformity in testing and to secure tests which will properly differentiate qualities and distinguish between acceptable and rejectable materials. The Society has therefore discussed the desirable properties of materials, and naturally it has dealt largely with the qualities and defects and with the nature of the uses of materials, and with the requirements accompanying those uses. As one function of the Society is to bring the producer and the consumer on common ground, the Society has dealt with specifications and requirements for the material; definite, explicit, and sane requirements, acceptable alike to producer and consumer, and these have come to form the basis for commercial contracts over the entire country. To secure the formulation and adoption of such specifications has involved an intimate contact between producer, consumer, and unattached expert in ways that have in themselves resulted beneficially to producer, consumer, and expert, as well as to the Society itself.

In considering these activities of the Society, it is apparent

that the constructive work of the Society must be based upon information,—definite, trustworthy, complete information, on the properties of materials, their action under stress, load, and time, and in combination with other parts in a machine or structure. Obviously, to get hold of this information and to pass upon its value must be within the province of the Society. The element of investigation, then, is vitally connected with the activities of the Society. It is to the question of research in engineering materials and the relation between research and the activities of the Society that I invite your attention for a brief time.

It is unnecessary in this audience to establish the need for definite, trustworthy and complete knowledge of the properties and actions of engineering materials. There was a time when general information, common belief, or even say-so opinion was all that was available for outlining specifications upon which material was to be purchased. Since the formation of the Society, great advance has been made in our real knowledge of materials, very much of it being due to the activities of the Society itself, and we are now where the value of the fruit of research is appreciated. As soon as the surface is scratched over, the need of systematic investigation becomes apparent. Ultimate progress involves a searching, critical, and thorough inquiry and investigation into the facts and principles relating to the subject. Real research lies at the basis of that complete and definite knowledge of the properties and actions of engineering materials that is so essential in the formulation of specifications for the selection of materials, and in the understanding of the nature of the resistance of the machines and engineering structures in which they are used; and more and more as time goes on will the Society need to avail itself of the fruits of research.

Fortunately for us, the agencies for gathering knowledge and for conducting research are many and varied, and their number and opportunities are increasing. First in time, and in the past perhaps first in opportunity, may be named the producer or manufacturer. Next to the producer may be mentioned the consumer, whose interests in research should be as large or larger than the producer's, though neither of these agencies has always realized its investigational opportunities and responsibilities. The private laboratory of the consulting engi-

neer, testing engineer, or chemist and the independent research institute constitute another agency. The various government laboratories, the engineering experiment stations, and the laboratories of engineering colleges and technological schools may be grouped together as still another agency. The list would not be complete without including an agency which has been especially productive in effective investigational work in the past few years, and which may be expected to render still more valuable service in the future,—I refer to cooperative work by scientific and engineering societies and their committees in connection with producer, consumer, scientific laboratories and individuals.

It is not easy to discuss this topic along general lines, since the problems to be considered vary so greatly in nature and complexity. Many of the matters are very simple—involve only a description of common wants or of the product commonly used, or comprise only a statement of the defects commonly found or of conditions to be avoided in manufacture or fabrication. Again, certain problems involve the possibility of manufacturing material having the desired qualities within a limit of cost of practical production. Information of the highest value is obtainable by systematic observation on the action of materials in use, their action under stress, their development of defects, their resistance to the effects of time, provided the exact nature of the materials is also known. Another class of problems requires the determination of internal action under stress or of resistance to external agencies, and these are generally complex problems which need special investigation, time-consuming and expensive research, diligent examinations and analysis, sometimes running over many years. I have in mind a research on a topic that is generally considered one of the simple matters connected with reinforced concrete, in which the results of the first two years' work were thrown away or used only as preliminary information or as a reconnaissance survey, and on which six years more were spent in a series of tests, the program of the tests of each year depending directly upon earlier tests and the interpretation and analysis of the results of the work of all the different years being interrelated and interdependent. Many of the problems still before the Society are even more complicated and

their solution will require long and careful investigations and critical and skilful analysis of data. In some lines of investigation the outcome may be only negative, and negative results are to be expected. Such tests are not wasted work, for if the conditions, methods, and data are placed on record, the results will be helpful in clearing the field for another method of attack.

There was a time when the knowledge of the properties of certain engineering materials emanated principally from the producer, or was even held by him as trade secrets. The manufacturer has special opportunities for learning the qualities of his output—in certain directions at least. He needs to know something of its properties, for during the initial stage of business he must develop his product, and generally he must work to develop its field of usefulness and applicability in order that his business may grow to proper proportions. Competition compels him to know about his product and perhaps about the product of his competitor. There was a tendency then to withhold information; the brand of the established house was held sufficient as a specification. Time has thrown purchase by brand into disuse except for small purchases. The brand of a cement or of boiler plate still has selling value, but the producer must contract to deliver an article which will comply with definite specifications. Buying by specification is considered to be of great advantage to the consumer, for it permits of intelligent competition and gives an agreed statement of what properties are wanted, and is it not therefore advantageous to the producer also? Granting purchase by specification, knowledge of the properties of a material is of great importance to the producer. And the producer is in a position to learn about his product. He is on the job continually. His chemist and his testing engineer keep tab on the work, and these trained and experienced men are able and willing to conduct researches to learn more of the material and of its action under varied conditions of service. A large amount of valuable investigation has been carried on by the producer. May we not expect with proper recognition of their work and with proper suggestion and cooperation that the fruits of the producer's research laboratories may multiply greatly in amount and in value to the public?

The consumer is in a different position: he has to live with

the material; he knows how it works, how it wears, whether it breaks and what the disastrous consequences are. He comes to think he knows what qualities he wants in the material, and he may ask for these qualities. The producer may have to tell him that it is not commercially practicable to make such a material, or he may insist that the cost would be prohibitive. The consumer may find that it will be to his advantage or to the advantage of his client, the public, to use the better material even at an increased cost, as in the case of the rail which reduces the chance for accident and loss of life. The consumer has many opportunities to learn the peculiarities of a material or a product; and the intelligent systematic record and analysis of failures or defects, of service and durability, add greatly to our knowledge of the properties of materials and may be made to form an even more important source of information. The laboratories of the consumer have been of great assistance in determining properties and in formulating adequate requirements, as is instanced in the work of the laboratory of the Pennsylvania Railroad Co. developed so highly under the leadership of our lamented former president, Doctor Dudley. But here again, with an increasing number of laboratories and with increased interest on the part of the consumer in the work of their laboratories, may we not expect, as the years go on, that the contributions to knowledge from these laboratories will increase many fold?

The next group, the private research laboratory, may at times serve the producer and at other times the consumer, in which cases it may be classified with the producer's and the consumer's laboratories; or it may serve as an independent research laboratory to investigate and report independently upon a research problem which is of common interest. This agency is also increasing in usefulness and we may expect its influence to grow with the years.

Government and college laboratories occupy an independent position. They enjoy the very full confidence of the public who feel that these laboratories are not connected with special interests and that research problems will be handled with judicial fairness and impartiality. These laboratories enjoy the further privilege of being able to devote time and money in researches into the principles of action and fundamental nature of materials,

which are seemingly of remote applicability and do not appeal directly to the producer or consumer but which finally, after a number of pieces of work have been completed and fitted together, may prove of intense practical value. Among these laboratories, the testing laboratories of the national government are rapidly assuming a place of inestimable value in the bearing of their work on the industrial and engineering interests of the country. A recent bulletin of the Society named a number of these government laboratories which have expressed a willingness to cooperate with the committees of the Society. The expansion of the Bureau of Standards in recent years is an instance of the growth of government testing, and presages something of future opportunities in investigations in engineering materials. In the field of college laboratories, there has been a development that may surprise those who have not kept informed. At least six engineering experiment stations have been organized in connection with the engineering departments of state universities. Research laboratories of similar purpose are connected with other engineering schools. Still other schools are doing investigational work in an informal way. From all these sources are coming contributions to engineering knowledge of great value in the form of bulletins and other papers. As these laboratories become better organized and their staffs acquire training and skill, is it not to be expected that this agency for research will become a powerful factor in the widening of our knowledge of engineering materials?

And now I come to the last of the research agencies to be named, one which I feel is most important in the work of the Society, and one on which the future progress of the Society greatly depends—cooperative work between the committees of engineering and scientific societies and the laboratories, facilities and store of information of the producer, consumer, and independent laboratory. This form of activity takes advantage of the knowledge and experience of the man who is familiar with the processes of manufacturing and their peculiarities and limitations; of the man who knows the needs and the shortcomings of the articles in use; and of the unattached expert who may be able to help to correlate the views and interests of the other two. It gives breadth and depth to the scope of the inquiry and purpose to the method of testing. It assists in the

analysis of data and the formulation of conclusions, and may aid in making the action of the Society more readily acceptable to all interests concerned. Doubtless, however, the element of patience may need to be developed in such an organization. You are all familiar with this form of activity in this Society and in other societies, and I need only refer to a few instances to bring to your mind the results which this agency has already accomplished. A case at hand is the report of Committee C-6 to be presented at this meeting, a very valuable piece of co-operative work on the methods of testing and on the available strength of both clay tile and concrete tile, made possible through the facilities of the Engineering Experiment Station of Iowa State College. Committee C-3 has now available valuable data on the strength of the building brick that are now in use in various parts of the country, secured through cooperation with college laboratories, and the same committee has recommended a standard method of testing paving brick based on a somewhat similar form of cooperation. The work of the committees on iron and steel and on preservative coatings furnish many similar examples. The report of the committee on concrete and reinforced concrete, which brought order out of chaos, was based on cooperative research work. Other societies are using the cooperative agencies. Several recent reports of committees of the American Concrete Institute include valuable research material obtained in this way. The American Railway Engineering Association has utilized this agency extensively, though its most important research, that on rail, which is destined to put rail purchase and rail use on a new basis, has been carried on almost independently. In the work of the committees of the American Society of Civil Engineers, the extensive tests of steel columns now being carried out form an interesting example of cooperative work. Perhaps the recently constituted joint committee of the two societies last named formed to investigate the stresses in railroad track — rail, fastenings, ties, ballast, and roadbed—will prove to be the most extensive piece of co-operative work yet undertaken.

I have named these examples of cooperative work to freshen your memory and to suggest the possibilities of this form of research. I want now to advocate the extension of its use as

an activity of the Society and to urge upon our committees the value of cooperative research work. It seems to me too that members may well encourage the making of larger appropriations for national, state, and semi-public laboratories, and may properly ask manufacturers and consumers themselves to support liberally research in all lines touching on engineering materials. The initiative for this cooperative work and its direction may well be left to the committees of the Society, whose members are so intimately interested in their work. Possibly some day there may need to be a general research committee of the Society to coordinate work and to stimulate opportunities. What is wanted now is a fuller understanding by the committees of their needs and opportunities and especially of a formulation and direction of the problems before them. Make cooperative research work a feature of the Society, and the fruits will be visible everywhere.

Research requires patience, diligence, and skill as well as knowledge and opportunity, from outlining the problem and separating the essentials from the non-essentials to analyzing the data and drawing conclusions. See that men of ability and training are selected for such work. Express appreciation of the results obtained and encourage the extension of the work. For one function of the Society is to widen our knowledge of materials.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE.

Publications.—The past year has been especially noteworthy from the standpoint of the Society in the unusually large amount of printed matter published and distributed, the summary being as follows:

	Pages	
Membership Pamphlet	190	
Index of Vols. I–XII	158	
Year-Book	401	
Proceedings, Vol. XIII	1141	
Total published and distributed		1890
Reports of Committee D-1 on Preservative Coatings for Structural Materials, 1903–1913	447	
Total published		2337
Sixth Congress Proceedings, International Association	2376	
Total published or distributed		4713

In addition to the foregoing, 699 pages of the Proceedings were preprinted, of which 461 pages were distributed among the members in advance of the last annual meeting. The remaining matter could not be printed in time for such advance distribution but was available at the meeting.

There have also been issued since the last annual meeting ten circulars of information.

The policy, inaugurated on an extensive scale for the first time last year, of preprinting committee reports and papers and distributing these among the membership at large in advance of their presentation at the annual meeting, has resulted, as anticipated, in increasing the volume and value of the discussions, besides affording an opportunity of participation to members who did not find it possible to attend the annual meeting. The

innovation of publishing a summary in connection with each paper has been inaugurated this year and will meet, it is believed, with favor.

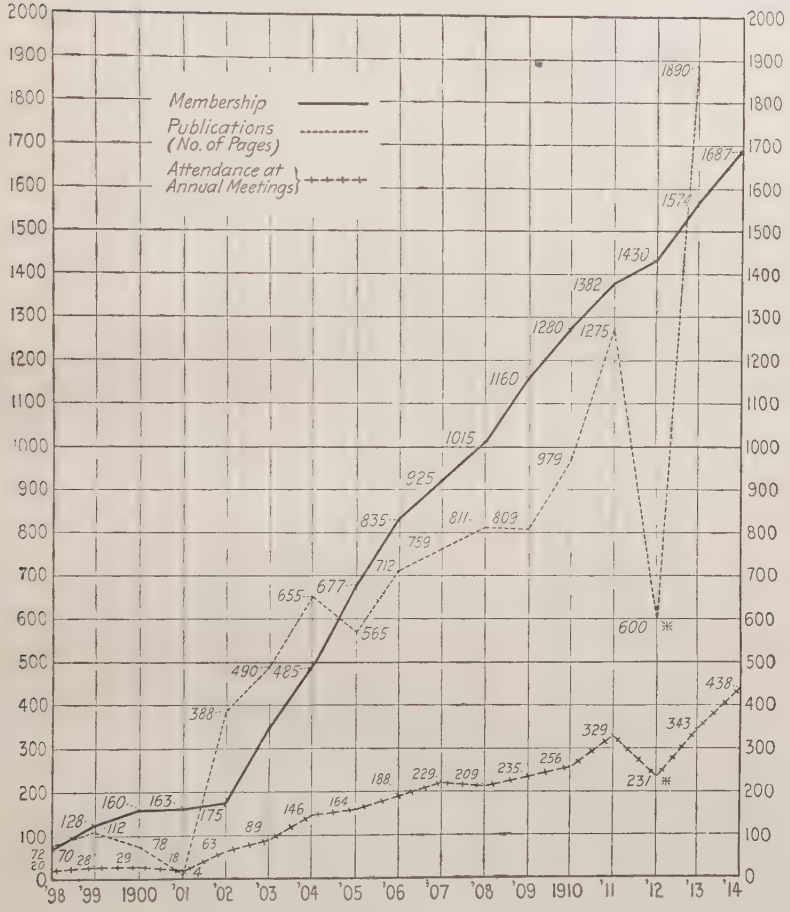
Membership.—The membership at the last annual meeting was 1574. Since then 265 applications for membership have been approved. The losses by death are 9, namely:

A. O. Anderson	May 16, 1913.
J. B. Cooper	February 27, 1914.
L. H. Dumary	March 16, 1914.
H. W. Gray	December 24, 1913.
Edgar Penny	November 4, 1913.
W. B. Riegner	January 19, 1914.
J. C. Rossi	January 21, 1914.
E. S. Sperry	January 31, 1914.
H. F. Walker	May 9, 1913.

The number of resignations is 64, and 79 members have been dropped for non-payment of dues. The total losses for the year from all causes number, therefore, 152. For unknown reasons, this number is relatively larger than in the past experience of the Society, although its effect has been offset by an increasingly large number of new applications for membership, of which, as above stated, 265 have been approved. This represents a net increase of 113 for the year as against an increase at the rate of 115 per annum reported last year for the preceding period of 15 months, and as against an average annual increase of 100 for the six years preceding the last. The total membership of the Society is now 1687.

Technical Committees.—The activities of the technical committees of the Society have been carried on during the past year with unabated vigor. A recent circular inquiry has shown that since the last annual meeting there have been 40 committee meetings and 79 sub-committee meetings, with a total attendance of about 1100. The results appear in part in the reports of these committees at this meeting.

Committee D-10 on Standardizing Explosives has been discharged in pursuance of its own recommendation.



*NOTE.—The marked drop in publications and attendance at annual meetings for the year 1912 is due to the fact that the Sixth Congress of the International Association for Testing Materials was held in New York in September, 1912, and that the activities of the American Society for that year were accordingly restricted to committee reports and administrative business.

The designation of the following committees has been changed:

Committee D-7 on Standard Specifications for the Grading of Structural Timber, will be known hereafter as Committee D-7 on Standard Specifications for Timber.

Committee E-6 on Papers will be known hereafter as Committee E-6 on Papers and Publications.

The personnel of Committee C-1 on Standard Specifications for Cement, and Committee D-7 on Standard Specifications for Timber, have been greatly increased during the year with a view of making them more thoroughly representative of the important interests in their respective fields.

The following three new committees have been created during the year:

Committee C-8 on Refractory Materials, under the temporary chairmanship of Mr. Edward Orton, Jr.

Committee C-9 on Standard Tests of Concrete and Concrete Aggregates. (Temporary chairman not yet appointed.)

Committee D-10 on Standard Tests and Specifications for Shipping Containers, under the chairmanship of Col. B. W. Dunn.

The total number of technical committees is now 36.

The attention of the technical committees has been formally called to the desirability, in the judgment of the Executive Committee, of formulating proposed standard definitions of terms in matters which fall within their respective fields, and in the case of terms which come within the province of two or more committees, by joint action through sub-committees of the committees concerned. It is intended to publish an alphabetical glossary of terms and their definitions in the Year-Book as soon as the number of standard definitions appears to warrant such action.

The Regulations Governing Technical Committees provide that any recommendations affecting specifications or other standards must be sent in printed form to every member of the Society not less than four weeks before the annual meeting at

which these recommendations are to be presented. This regulation has been strictly observed, and is applicable to the following matter to be introduced at this meeting:

PROPOSED NEW STANDARD SPECIFICATIONS.

Recommended by Committee A-1 on Steel:

For Structural Steel for Cars.
For Carbon-Steel Bars for Springs.
For Methods of Chemical Analysis for Plain Carbon Steel.

Recommended by Committee A-4 on Heat Treatment of Iron and Steel:

Recommended Practice for the Annealing of Carbon-Steel Castings.
Recommended Practice for the Heat Treatment of Case-Hardened Carbon-Steel Objects.

Recommended by Committee A-8 on Cold-Drawn Steel:

For Cold-Drawn Steel: Bessemer Automatic Screw Stock.

Recommended by Committee C-6 on Drain Tile:

For Strength Tests of Drain Tile.
For Quality of Drain Tile.
Recommended Practice for the Design and Construction of Tile Drain.

Recommended by Committee C-7 on Lime:

For Quicklime.
For Hydrated Lime.

Recommended by Committee D-1 on Preservative Coatings for Structural Materials:

Standard Definitions of Terms used in Paint Specifications.

Recommended by Committee D-2 on Lubricants:

Provisional Tests for Lubricants.

Recommended by Committee D-4 on Road Materials:

Provisional Test for the Determination of Apparent Specific Gravity of Rock.
Provisional Test for the Determination of the Absorption of Water per Cubic Foot of Rock.

Provisional Method for Making a Mechanical Analysis of Broken Stone or Broken Slag.

Provisional Method for Making a Mechanical Analysis of Mixtures of Sand or other fine Material with Broken Stone or Broken Slag.

Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements.

Recommended by Committee E-1 on Methods of Testing:

Standard Methods for Brinell Hardness Tests of Metals. (To be incorporated in the Standard Methods of Testing.)

PROPOSED REVISION IN STANDARD SPECIFICATIONS.

Recommended by Committee A-1 on Steel:

For Carbon-Steel Rails.
For Low-Carbon-Steel Splice Bars.
For Medium-Carbon-Steel Splice Bars.
For High-Carbon Steel Splice Bars.
For Extra-High-Carbon-Steel Splice Bars.
For Structural Steel for Bridges.
For Structural Nickel Steel.
For Structural Steel for Buildings.
For Structural Steel for Locomotives.
For Billet-Steel Concrete Reinforcement Bars.
For Carbon-Steel and Alloy-Steel Forgings.
For Quenched and Tempered Carbon-Steel Axles, etc.
For Carbon-Steel Forgings for Locomotives.
For Carbon-Steel Car and Tender Axles.
For Cold-Rolled Steel Axles.

Recommended by Committee A-2 on Wrought Iron:

For Staybolt Iron.

Recommended by Committee A-3 on Cast Iron:

For Locomotive Cylinders.

Recommended by Committee A-6 on Magnetic Testing:

Magnetic Tests of Iron and Steel.

Recommended by Committee B-2 on Non-Ferrous Metals:

For Spelter.

For Manganese-Bronze Ingots.

Recommended by Committee E-1 on Methods of Testing:

Methods of Testing.

During the year many changes have been made in the Regulations Governing Technical Committees by joint action of Committee E-5 and the Executive Committee. These changes appear in detail in the report of Committee E-5 and are therefore not repeated here.

Finances.—The Executive Committee has approved the following Regulations Governing the Finance Committee:

1. The books and accounts of the Society shall be audited semi-annually by certified public accountants. The accountants shall be appointed by or shall be approved by the Finance Committee.

2. A copy of the semi-annual report of the auditors shall be transmitted to the Chairman of the Finance Committee as soon as it is received by the Secretary-Treasurer, in order that the Finance Committee may be prepared to make such suggestions, criticisms or inquiries as it may see fit at the next meeting of the Executive Committee. The Chairman of the Finance Committee shall furnish the Secretary-Treasurer with a statement embodying such suggestions, criticisms or inquiries in advance of the meeting of the Executive Committee at which these matters are to be presented.

3. During the second week of each month all vouchers for accumulated bills, and salary vouchers for the current month (the latter payable at the end of the month), shall be sent to the Chairman of the Finance Committee, or to a member of that committee designated by the chairman, for counter signature. The Secretary-Treasurer shall pay no bills—except in case of emergencies for which he shall be accountable to the Chairman of the Finance Committee—unless the corresponding vouchers have been thus countersigned.

4. The Chairman of the Finance Committee shall be authorized to approve, jointly with the Secretary-Treasurer, proposed expenditures for account of a technical committee up to $250 during a given quarter, without previous specific authorization by the Executive Committee, and such expenditures are to be reported by the Secretary-Treasurer at the following quarterly meeting of the Executive Committee.

5. The Secretary-Treasurer shall be authorized to maintain a petty cash fund of $100 on which he shall be authorized to draw without previous approval of the proposed expenditures on the part of the Finance Committee. Of this fund not more than $25 may be carried in cash to meet expenditures for expressage, telegrams, etc. Vouchers covering expenditures out of this fund shall be submitted monthly for approval by the Finance Committee.

6. Any recommendation affecting salaries, and proposed extraordinary expenditures out of the general funds of the Society, as distinguished from the petty cash fund, shall be submitted to the Finance Committee for approval before presentation to the Executive Committee for final action.

7. The Secretary-Treasurer shall obtain competitive bids for printing and binding the publications of the Society at intervals of not over five years. The results shall be submitted to the Finance Committee in time for presentation at the January quarterly meeting of the Executive Committee, beginning with this meeting in 1916, and thereafter at intervals of not over five years.

8. The Finance Committee shall be authorized to inspect the books and accounts, etc., of the Society at any time, and such inspection shall be made at least once in two years.

A comparison of the annual report of the Secretary-Treasurer with his report last year should be made with the understanding that the latter covers a period of fourteen and one-half months as against a twelve-month period included in the present report. This applies particularly to such items as proceeds from the sale of publications, disbursements for salaries, etc., and, though in a much less pronounced way, to receipts from membership dues and cost of publications. Reduced to an equivalent twelve-month basis, the proceeds reported last year from the sale of publications amount to about $2100 as compared with $3911.95 for the past year. This remarkable increase is attributable, in large part, to the receipts from the sale of the special publication containing the reports of Committee D-1 on Preservative Coatings for Structural Materials, for the years 1903–1913, amounting to a total of $1225. The total cost of an edition of 1000 copies of these reports, as indicated hereafter in the analysis of disbursements for account of publications, is $1589.72. About 400 unbound copies of this volume remain on hand, it being intended to bind a certain number of this surplus from year to year under the same cover with the added annual reports of the committee. If the entire proceeds from the sale of this publication are deducted there still remains an increase of nearly $600 in the net proceeds from the sale of publications this year as compared with the previous year, of which only $50 represent the returns from the sale of the Index of Vols. I–XII of the Proceedings.

The total cost of publications is over twice as great as their average cost for the previous two years. This is due to (1) the

unprecedented increase in size of Vol. XIII, which contains 1141 pages as against the largest previous volume, issued in 1909, which contains 890 pages; (2) the large cost of having the material for all line cuts redrawn by experts; (3) the policy, first inaugurated on an extended scale last year, of issuing preprints in advance of the annual meeting of which the cost is $1068.02; (4) the cost of the Index of Vols. I–XII of the Proceedings ($1231.24), and of the volume, previously referred to, containing the reports of Committee D-1 ($1589.72); (5) the cost ($1517.18) of binding and distributing the Proceedings of the Sixth International Congress, and (6) the augmented cost of the Year-Book owing to its increased size.

Notwithstanding these extraordinary expenditures, which in part are not of a recurring nature, the report shows a cash balance on June 1, 1914, of $7834.60, as against a cash balance of $9444.39 on June 1, 1913.[1] It should be stated that the balance reported this year includes a net unexpended balance of $507.14, from the unexpended balance of $1796.82 for Congress purposes included in last year's report. After the defrayment of the cost of binding and distributing the Congress Proceedings among the members of the American Society, the net balance of $507.14 was transferred to the general funds of the Society by action of the Executive Committee.

In the past experience of the Society it has never been possible to cover the cost of the publications for a given year from the receipts for that year. That is to say, there has always been a deficit on January 1, the beginning of a new fiscal year, of which the Secretary-Treasurer's annual reports have given no direct evidence. It is estimated that this year it will be possible to defray the current expenses for the year out of the receipts, and it is hoped that a surplus will also be available to partially offset the expenditures out of the receipts for the current fiscal year which have been applied to the payment of obligations incurred during the previous year.

The salary of the Secretary-Treasurer has been increased from $2500 to $3600 per annum from January 1, 1914.

[1] The cash balance, June 1, 1913, of $11,241.21 in the sub-joined annual report of the Secretary-Treasurer includes the above cash balance of $9444.39 and the then unexpended balance of $1796.82 from the funds for Congress purposes.

ANNUAL REPORT OF THE SECRETARY-TREASURER

From June 1, 1913, to June 1, 1914.

RECEIPTS.

Membership dues		$15 873.02
Sale of Publications		3 911.95
Binding Proceedings		272.50
Authors' reprints		642.82
Sales of right to reprint specifications for one year		600.00
Interest on deposits		171.94
Unclassified receipts		12.22
International Association dues		2 311.00
Total receipts		$23 795.45
Cash balance, June 1, 1913		11 241.21
		$35 036.66

DISBURSEMENTS.

Publications		$17 202.22
Salaries (including Secretary-Treasurer's salary at the rate of $2500 per annum, prior to January 1, 1914, and $3600 per annum subsequent to that date)		4 969.14
Audits by public accountants		80.00
Rent and insurance, storage room		141.60
Expenses, Secretary-Treasurer's office:		
Postage and expressage	$530.52	
Miscellaneous expenses	432.18	
		962.70
Expenses, Technical Committees		1 071.55
Stenographer, Sixteenth Annual Meeting		200.00
Expenses, Sixteenth Annual Meeting		202.04
Expenses, Nominating Committee		107.15
Refund of excess remittances		14.60
Unclassified disbursements		11.50
Remitted to International Association:		
Dues	$2,311.00	
Less expenses	71.44	
		2,239.56
Total disbursements		$27 202.06
Cash balance, June 1, 1914		7 834.60
		$35 036.66

ANALYSIS OF DISBURSEMENTS FOR ACCOUNT OF PUBLICATIONS.

	Clerical Services.	Printing and Mailing.	Total.
Membership Pamphlet	$57.00	$552.40	$609.40
Year-Book	101.00	1 732.75	1 833.75
Proceedings	650.04	6 637.28	7 287.32
Index of Vols. I–XII	61.10	1 170.14	1 231.24
Reports of Committee D-1	24.10	1 565.62	1 589.72
Circulars to Members	.....	697.99	697.99
Preprints	18.00	1 050.02	1 068.02
Reprints	.....	675.77	675.77
Miscellaneous	78.95	612.88	691.83
Binding and distributing Sixth International Congress Proceedings	.....	1 517.18	1 517.18
	$990.19	$16 212.03	$17 202.22

COMMITTEE FUNDS.

Committee D-1.

Cash balance, June 1, 1913, $143.93.
(No receipts or disbursements during the year.)

The last report of the semi-annual audit of the books and accounts of the Society, presented on January 13, 1914, is as follows:

John Heins & Co.
PUBLIC ACCOUNTANTS AND AUDITORS.

Philadelphia, January 13, 1914.

Mr. Edgar Marburg, *Secretary-Treasurer*,
American Society for Testing Materials.

Dear Sir:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1913, and report them to be correct, and that the accounts are in the same excellent condition as at our last examination.

We submit balance sheet as of December 31, 1913, as also a statement of operations for the twelve months then ended, schedules of accounts receivable and payable, etc.

Yours respectfully,

(Signed) John Heins & Co.

Proposed Amendment of the By-Laws.—At the last annual meeting the following resolution was passed:

> "That the Executive Committee be requested to draw up, if in its judgment it is desirable to do so, proposed amendments to the by-laws by which the scheme of nomination of officers would be made such that the membership at large may participate individually, directly or indirectly, in these nominations, and that the report of the Executive Committee in this matter be made not later than February 1, 1914."

In pursuance of this resolution the Executive Committee, after careful consideration of the methods and experiences of other leading national technical societies, formulated certain proposed amendments of the by-laws affecting the nomination and election of officers, which were announced in Circular No. 84, issued last January. In addition to these proposed changes the Executive Committee has deemed it wise to propose a complete revision of the by-laws. A copy of the by-laws in their proposed completely revised form was issued in May in connection with Circular No. 86, and appears as Appendix II to this report for action at this meeting. The italicized parts represent proposed new matter; old matter, which it is proposed to cancel or supersede, is shown stricken out, so that all changes are readily apparent.

Certificate of Membership.—The newly adopted official Certificate of Membership in the Society is here shown in reduced form.[1] This certificate is 17 by 22 in. in size and may be obtained by members at the following prices: On parchment paper, $2.00; on parchment skin, $2.50. Orders accompanied by the appropriate remittance should be addressed to the Secretary-Treasurer.

Basis of Cooperation Between Various Government Branches and the Technical Committees of the Society.—For the information of the membership at large, and especially the technical committees, the Executive Committee has authorized the following announcements, in alphabetical order, of the conditions under which certain government branches are prepared to

[1] The Certificate of Membership has been omitted here, but is shown in reduced form opposite page 207 of the 1914 Membership Pamphlet.—ED.

cooperate with the work of the technical committees, these announcements having been prepared by, or with the approval of, the directing heads of the government branches concerned:

Bureau of Chemistry.—This Bureau is equipped to do all kinds of chemical work and to participate in cooperative work whenever it can be done within the scope of the functions of the Bureau and under the law, inasmuch as the activities of the Bureau are specifically prescribed by acts of Congress. This cooperative feature would include the investigations under way and such as might be undertaken in connection with the work of the Bureau along the lines of its natural growth and development.

In so far as the Bureau has equipment suitable to carry on investigations and cooperative work on such subjects as are related to chemistry, and with which the American Society for Testing Materials is directly concerned, and where the proper authorization exists and funds are available for the purpose, it would be glad to be of assistance to the committees of the Society.

Bureau of Mines.—The Bureau of Mines may make tests of fuels, explosives and certain mining appliances, such as lamps, timbering, etc. When such work is performed other than for the Government of the United States or state governments, a reasonable fee to cover the necessary expenses is charged.

The Bureau is prepared to cooperate, and will welcome opportunities for cooperation, with committees of your Society to the extent of being represented on such committees as are concerned in tests or investigations of fuels, explosives or miners' lamps, and will conduct investigations or tests concerning any phase of these which may be brought to its attention by your committees as needing solution, providing it concerns subjects in which the Bureau is interested on behalf of increasing safety in mining or use of fuels purchased for or belonging to the United States.

Bureau of Standards.—The Bureau of Standards is equipped to conduct investigations covering the standardization of weights and measures, electrical measurements, the determinations of heat constants and temperature measurements, optical properties of materials, chemical problems, investigations of structural and engineering materials, and metallurgical investigations. In addition to general research investigations, it studies problems which arise in the preparation of specifications or the development of methods of testing required in the determination of the qualities of materials. Much of the work is closely allied to the work of the technical committees of the Society and it is the desire of the Bureau to cooperate in those investigations where the Bureau is equipped for them. Investigations may be referred to the Bureau which fall within the authorized scope of its functions, and will be taken up as far as equipment and funds will permit.

Forest Products Laboratory.—It is the aim of the Forest Products Laboratory to promote economy and efficiency in the utilization of wood and in the processes by which forest materials are converted into commercial pro-

ducts. Investigations at the laboratory are being made along the following lines:

Mechanical and physical properties of woods and derived products.
Principles of seasoning and kiln drying.
Decay, preservative treatment, and fireproofing of wood.
Manufacture of pulp and paper.
Distillation and chemical constituents of forest products.
Specifications and grading rules for forest products.
Efficient design or composition of articles obtained or manufactured from forest products.
Design of apparatus, specifications for material, and improving of processes to promote a more efficient and closer utilization of forest products.

In order to further the application of the work of the laboratory it is necessary to correlate the results of all technical investigations with the uses of the products and to make all information available to the public.

The laboratory, in all matters within its scope, will be glad to cooperate with the Society so far as funds and equipment are available.

Office of Public Roads.—The Office of Public Roads will cooperate with the American Society for Testing Materials along all lines of laboratory or field work relating to road materials. The Office has all the necessary equipment for making such tests. The Office can also cooperate along any reasonable lines of field investigations.

Watertown Arsenal.—The laboratory of the Watertown Arsenal is equipped for conducting physical tests of metals and materials, including impact and repeated stress tests; metallographic examinations of metals, chemical analys s, pyrometric work and investigations on the manufacture and heat treatment of steels. The testing laboratory is limited by law to investigate tests and tests of material in connection with the manufacturing work of the Ordnance Department, except as modified by authority to make tests of materials for private parties paying the cost of the test. Within these limits the Watertown Arsenal will be glad to cooperate with the technical committees of the Society.

International Engineering Congress.—Attention is called to an invitation that has been officially extended to the officers and members of the Society to attend and participate in the International Engineering Congress, to be held in San Francisco, September 20-25, 1915, under the joint auspices of the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers.

International Association for Testing Materials.—The recognition of American interests in the International Association for Testing Materials through the appointment of Mr. Henry M. Howe to life membership in the Council was followed recently by the election of Mr. Robert W. Hunt to a vice-presidency in that organization.

The next International Congress will be held in St. Petersburg, Russia, on August 12–17, 1915. The features of special interest to American members in the recent proceedings of the Council meeting, held at Turin on April 3-4, 1914, will be reported at this meeting by Mr. Henry M. Howe and Mr. Richard Moldenke. It is not necessary, therefore, that these should be mentioned here.

It is to be earnestly hoped that this country will be creditably represented at the approaching Congress both through technical contributions and through attendance on the part of American members.

The Executive Committee has followed the example of other countries in authorizing a yearly subscription of 100 francs to the International Association in support of its membership as a body in that Association.

It was to be expected that the American membership in the International Association should show some decline following the New York Congress. The present membership is 571 as against a maximum of 627 in 1912. The prospective valuable returns from the Proceedings of the St. Petersburg Congress should serve as a strong incentive towards an increase of membership to which end the American members are invited to cooperate.

Respectfully submitted on behalf of the Executive Committee,

ARTHUR N. TALBOT,
President.

EDGAR MARBURG,
Secretary-Treasurer.

[NOTE.—The proposed amendments of the by-laws as given in Appendix II, pages 68–75, were adopted by letter ballot of the Society on September 10, 1914. The by-laws in their amended form appear on pages 7–13 of the 1914 Membership Pamphlet.—ED.]

APPENDIX I.

ABSTRACT OF THE MINUTES OF THE EXECUTIVE COMMITTEE.

Regular Meeting, June 25, 1913.—Hotel Traymore, Atlantic City, N. J. Present: Mr. A. N. Talbot, President; Mr. A. W. Gibbs and Mr. Richard Moldenke, Vice-Presidents; Mr. John Brunner, Mr. Chas. S. Churchill, Mr. John B. Lober, Mr. A. A. Stevenson and Mr. S. W. Stratton, members of the Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer; and on invitation Mr. C. E. Skinner and Mr. G. W. Thompson of the outgoing Executive Committee.

The Secretary-Treasurer reported that favorable action had been taken on 44 applications for membership; that 4 members had resigned, 48 members had been dropped for non-payment of dues, and that the Society had suffered the loss by death of 2 members, making the total membership on June 20, 1913, 1574.

The Secretary-Treasurer presented a report from Committee D-6 on Standard Specifications for Coke recommending its continuation which was, on motion, approved.

It was decided to authorize the Secretary-Treasurer to proceed with the preparation of the publication in one volume of the annual reports of the Committee on Preservative Coatings for Structural Materials from 1903 to 1913, inclusive, with the understanding that the selling price in cloth binding will be $2.50, postage prepaid, with a discount of 25 per cent on orders in lots of 100 or more.

The Secretary-Treasurer submitted some recent correspondence with Mr. S. W. Stratton, Director of the U. S. Bureau of Standards, relative to plans for closer cooperation on the part of the Bureau and the technical committees of the Society. It was decided to authorize the President, the Secretary-Treasurer and the Director of the Bureau of Standards to draw up a statement for circulation among the members of the technical committees and for publication in the Year-Book, in which attention is to be called to the conditions under which such cooperation with the Bureau of Standards might be made effective.

The Secretary-Treasurer reported the substance of correspondence with Mr. C. A. Mailloux, President-elect of the American Institute of Electrical Engineers, designed to bring about closer cooperation between the national societies in the broad field of standardization. It was decided to record the sense of the Executive Committee as favorable in principle to this proposal, but that further action be deferred pending the receipt of more definite information.

The Secretary-Treasurer presented a communication under date of June 16 from Mr. C. A. Adams, Secretary of the Standards Committee of the American Institute of Electrical Engineers, containing the following

copy of the resolution of the Board of Directors of the A. I. E. E. concerning cooperation between the Standards Committee of the Institute and similar committees of kindred societies:

"*Resolved*, That it is the sense of this Board that cooperation between the Standards Committee of the Institute and the standards committees of other national societies dealing with units and standards appertaining to or applicable in electrical engineering, or in the allied arts and sciences, is desirable, and it suggests that the Standards Committee shall take no action on any subject matter outside of the field of electrical or magnetic standardization, and within the field of the Standards Committee of another national society, before coming to an agreement with the Standards Committee of that society, provided that a reciprocal courtesy is extended by such Standards Committee of such Society.

This resolution was followed by an explanatory note on the part of the Standards Committee, namely:

"As you will doubtless realize, the above resolution, while designed to harmonize cooperation between Standards Committees on kindred subjects, was not intended to destroy the liberty of action of any Standards Committee in case agreement could not be secured."

It was decided to accept the invitation for cooperation with the Standards Committee on behalf of the technical committees affected, subject to the provision expressed in the above explanatory note.

The Secretary-Treasurer reported that at a meeting of the Council of the International Association for Testing Materials, held at Amsterdam, March 15, 1913, action was taken in the matter of dues by which (1) every member of the International Association will be required to pay minimum dues of 12.50 francs; new members joining after April 1, 1913, will be required to pay annual dues of 20 francs, and (2) the total annual receipts from each country, including subscriptions and membership dues, must aggregate not less than 20 francs per member.

The Secretary-Treasurer reported that some differences of opinion had arisen as to whether the outgoing President or the President-elect should preside at the annual meeting of the Society. It was decided to authorize the President and Secretary-Treasurer to draw up proposed amendments to the by-laws, to be submitted at the next meeting of the Executive Committee, by which it should be made explicit that the outgoing President shall preside at the annual meeting at which his successor is elected.

It was the sense of the committee that the meaning of the present by-laws should be so construed.

The Secretary-Treasurer reported the following motion on the part of Mr. C. D. Rinald, which had been introduced at the afternoon session of the annual meeting on June 24 and referred to the Executive Committee for consideration, namely:

"That all members of the American Society for Testing Materials, either firms or individuals, who by their contribution of material shall make possible the conduct of tests that may have been decided upon by a committee or sub-committee, shall thereby become non-voting members of such com-

mittees. They shall be notified in advance of all meetings and inspection of such committees at which they may have their representatives, and they shall also receive all information furnished to members of such committee. Nobody connected either directly or indirectly with contributing firms or individuals shall be allowed to vote on competing articles."

It was decided to instruct the Secretary-Treasurer to refer this resolution to the officers of the various technical committees concerned with subjects having a commercial bearing for expressions of opinion as to the desirability of its adoption, before taking further action.

It was decided to introduce the following resolution at one of the sessions of the annual meeting, with the understanding that in case of an affirmative vote the question be also submitted to letter ballot of the Society:

"That from and after September 1, 1913, the Regulations Governing Technical Committees be made applicable to all existing technical committees of the Society, irrespective of the circumstance that the organization of certain committees antedated these regulations."

The President and Secretary-Treasurer were instructed to prepare proposed modifications of the Regulations Governing Technical Committees with respect to the provisions for the discharge of technical committees, for presentation at the next meeting of the Executive Committee.

REGULAR MEETING, October 6, 1913.—Engineers' Club, Philadelphia. Present: Mr. A. N. Talbot, President; Mr. A. W. Gibbs, Vice-President; Gen. W. H. Bixby, Mr. John Brunner, Mr. F. H. Clark, and Mr. Albert Sauveur, members of the Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 67 applications for membership; that 3 members had resigned, and that the Society had suffered the loss of one member by death, making the total membership on October 1, 1913, 1637.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended June 30, 1913, and certifying to their correctness.

It was decided to discontinue the standing committees of the Executive Committee on (*a*) Publications, and (*b*) Membership, and to authorize the President to appoint a Committee on Finance, with the understanding that this committee be instructed to prepare proposed regulations governing its duties, and to submit these at the next meeting of the Executive Committee.

The Secretary-Treasurer stated that the recent letter ballot on the amendment of the by-laws; the revision of certain standard specifications; the adoption of certain new standard specifications; and on the following special resolution:

"*Resolved*, That from and after September 1, 1913, the Regulations Governing Technical Committees shall be made applicable to all existing technical committees of the Society, irrespective of the circumstance that the organization of certain committees antedated these regulations,"

had been canvassed by a committee of tellers consisting of Mr. A. T. Goldbeck and Mr. W. P. Taylor, who reported the following results:

ON REVISED SPECIFICATIONS.	For Adoption	Against Adoption
Steel Splice Bars	94	3
Structural Steel for Bridges	102	3
Structural Nickel Steel	98	3
Structural Steel for Buildings	101	4
Steel Reinforcing Bars	106	4
Steel Axles	101	0
Steel Tires	85	3
Steel Castings	96	0
Lap-Welded and Seamless Steel Boiler Tubes	98	0
Automobile Carbon and Alloy Steels	95	3
Boiler and Firebox Steel	97	3
Boiler Rivet Steel	99	4
Annealed Steel Forgings	102	0
Steel Shapes, Universal Mill Plates, and Bars	104	0
Refined Wrought-Iron Bars	89	0
Engine-Bolt Iron	84	0
Hard-Drawn Copper Wire	75	5
Medium Hard-Drawn Copper Wire	75	5
Soft or Annealed Copper Wire	76	4
ON NEW SPECIFICATIONS.		
Medium-Carbon Steel Splice Bars	83	0
High-Carbon Steel Splice Bars	97	0
Extra-High-Carbon Steel Splice Bars	85	11
Structural Steel for Ships	99	0
Rivet Steel for Ships	99	0
Rail-Steel Concrete Reinforcement Bars	99	8
Cold-Rolled Steel Axles	93	4
Wrought Solid Carbon-Steel Wheels for Electric Railway Service	84	4
Blooms, Billets and Slabs for Carbon-Steel Forgings	95	7
Wrought-Iron Plates	81	4
Electrolytic Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars	77	3
Lake Copper Wire Bars, Cakes, Slabs, Billets, Ingots, and Ingot Bars	77	3
Purity of Raw Linseed Oil from North American Seed	84	0
MISCELLANEOUS.		
On omission of Sec. 5, Art. II, of the by-laws	91	1
On Special Resolution	101	3

Total number of legal votes cast, 135.

A communication from the W. S. Tyler Co. relative to the adoption of a standard sieve series, with a fixed ratio between the openings, for cement and sand, was referred to Committee C-1 on Standard Specifications for Cement.

It was decided that, if agreeable to Mr. Cloyd M. Chapman, a committee would be appointed consisting of himself and one representative from each of the standing technical committees dealing with plastic materials, to conduct tests with his apparatus for consistency of plastic materials with the understanding that, even though the results should be entirely satisfactory, the Executive Committee would not feel warranted in accepting, on behalf of the Society, Mr. Chapman's proposal to assign the invention and apparatus to the Society.

It was decided to change the designation of the Committee on Papers to the "Committee on Papers and Publications."

The Secretary-Treasurer was instructed to communicate with the various technical committees recommending that active work be initiated this fall, and requesting each committee to outline briefly the prospective work for the year, for presentation to the Executive Committee at its next quarterly meeting.

It was decided to adhere to the present practice of making no allusion to the commercial or professional relations of authors in the Proceedings of the Society.

The Secretary-Treasurer reported the appointment by the President of the following delegates:

American Road Congress, Detroit, Mich., September 29 to October 4, 1913: Mr. Prevost Hubbard, Mr. A. N. Johnson, Mr. Clifford Richardson.

National Conservations Congress, Washington, D. C., November 18 to 20, 1913: Mr. C. S. Churchill, Mr. R. L. Humphrey, Mr. S. W. Stratton.

International Petroleum Commission, Bucarest, October, 1913: Mr. Irving C. Allen.

The Secretary-Treasurer called attention to the recent creation of the American Petroleum Society, and in that connection presented a letter under date of October 4 from Mr. I. C. Allen, Secretary of that Society and Chairman of Committee D-12 on Petroleum Products of the American Society for Testing Materials, containing the following recommendation:

"That the Executive Committee of the American Society for Testing Materials authorize its Committee D-12 on Petroleum Products, to take such steps as may be necessary to enter into hearty cooperation with the American Petroleum Society and the U. S. Bureau of Mines for the furthering of the general knowledge of the testing of petroleum products."

On motion this recommendation was approved.

The recommendation on the part of Committee D-10 on Standardizing Explosives that it be discharged, was approved.

The President and Secretary-Treasurer were authorized to proceed with the creation of the Committee on Shipping Containers, and to invite Col. B. W. Dunn to accept the temporary chairmanship of that committee.

The President and Secretary-Treasurer were authorized to proceed with the creation of the Committee on Refractory Materials, and to invite Mr. Edward Orton, Jr., to accept the temporary chairmanship of that committee.

The Secretary-Treasurer presented some correspondence with Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, from which it appeared that the standard paint definitions, proposed by that committee at the last annual meeting, had not been submitted to letter ballot of the Society because the Secretary-Treasurer considered that he had no authority to do so in view of the fact that some of these definitions had not been printed in the Proceedings for a year, as required by the Regulations Governing Technical Committees. The Secretary-Treasurer's position in this matter was sustained.

The Secretary-Treasurer reported, as the result of an inquiry which he had been instructed to institute in connection with the resolution introduced by Mr. C. D. Rinald at the last annual meeting of the Society (see minutes of Executive Committee, June 25, 1913) that 15 officers of technical committees had expressed themselves favorably to this proposal, 13 unfavorably, and that 3 had refrained from any expression of opinion.

It was decided that it would be inadvisable to adopt the terms of this resolution in the Regulations Governing Technical Committees.

The Secretary-Treasurer submitted correspondence with Mr. A. L. Johnson, relating to the present procedure governing the adoption of standard specifications by the Society. In that connection the Secretary-Treasurer presented an editorial from the *Railway Age Gazette*, of August 1, and a recommendation from Committee A-1 on Standard Specifications for Steel, that Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, be instructed to report to the Executive Committee on desirable changes, if any, in the present methods of amending and adopting committee reports and specifications.

This recommendation was approved.

The President was authorized to appoint a committee to consider the revision of the present by-laws, especially in their bearing on (*a*) the method of nominating and electing officers and members of the Executive Committee, and (*b*) the termination of the active term of office of the President.

The following proposed changes in the Regulations Governing Technical Committees were, on motion, approved and referred to Committee E-5 on Regulations Governing the Form but not the Substance of Specifications:

1. That in the paragraph relating to "Reports" the second sentence be stricken out and the following substituted:

"Such reports must first have been submitted to letter ballot of the committee and must have received the approval of the majority of those voting. A statement of the following form shall appear at the close of every committee report:

"This report has been submitted to letter ballot of the committee, which consists of.....members, of whom.....have voted affirmatively, ... negatively, and .....have refrained from voting."

2. That the following new paragraph be inserted after the present paragraph relating to "Publications:"

"*Stationery.*—Correspondence relating to the business of committees or sub-committees shall be conducted on official stationery, which will be furnished by the Secretary of the Society."

3. That the paragraph relating to "Current Expenses" be changed to the following form:

"*Current Expenses.*—Expenses for postage incurred in connection with the business of committees will be refunded by the Treasurer of the Society on vouchers approved by the chairmen of these committees."

4. That the following sentence be added at the end of the paragraph on "Discharge of Committees:"

"Technical committees may be discharged for cause by the Executive Committee at its own initiative."

The Secretary-Treasurer presented a recommendation on behalf of Committee A-1 on Standard Specifications for Steel, that the recently adopted regulations governing that committee be printed in the Year-Book. This recommendation was approved.

The Secretary-Treasurer reported the election of the following new officers of Committee A-3 on Standard Specifications for Cast Iron and Finished Castings, in pursuance of a resolution adopted at the last annual meeting and confirmed by letter ballot of the Society: Chairman, Mr. Richard Moldenke; Vice-Chairman, Mr. Walter Wood, and Secretary, Mr. George C. Davies.

The Secretary-Treasurer presented an invitation from the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers to the officers and members of the Society to attend and participate in the International Engineering Congress, to be held in San Francisco, September 20 to 25, 1915; and an invitation from Mr. Chas. F. Hatfield, Field Secretary of the Panama-Pacific International Exposition, to hold the 1915 annual meeting of the Society in San Francisco.

The Secretary-Treasurer was instructed to express the thanks of the Executive Committee for these invitations, and its regrets that, in its judgment, it would not be compatible with the best interests of the Society to hold the 1915 annual meeting in San Francisco.

REGULAR MEETING, January 20, 1914, Union League, Philadelphia. Present: Mr A. N. Talbot, President; Mr. A. W. Gibbs and Mr. Richard Moldenke, Vice-Presidents; Gen. W. H. Bixby, Mr. John Brunner, Mr. F. H. Clark, Mr. John B. Lober, Mr. A. A. Stevenson, and Mr. S. W. Stratton, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer; Mr. Henry M. Howe, Life Member I. A. T. M. Council; and Capt. Robert W. Hunt, American Representative on I. A. T. M. Council.

The President called upon Mr. Howe to address the Executive Committee on the general question of American subventions to the International Association. Following a general discussion it was decided that the President should appoint a committee of three to consider this subject and to report its recommendations to the Executive Committee.

The Secretary-Treasurer reported that favorable action had been taken on 34 applications for membership; that the Society had suffered the loss of one member by death, and that 48 members had resigned, making the total membership in the Society, 1622.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended December 31, 1913, and certifying to their correctness.

The Secretary-Treasurer reported the appointment by the President of the following committee, in pursuance of action at the last meeting, to conduct tests for consistency with the Chapman apparatus:

Mr. C. M. Chapman, Chairman; Mr. R. L. Humphrey, representing Committee C-1; Mr. C. S. Reeve, representing Committee C-7; Mr. W. E. Emley, representing Committee D-4.

It was decided to publish a special volume containing certain selected Standard Specifications of the Society, designed for use in engineering schools, if the returns from a circular inquiry addressed to such schools should appear to warrant such a publication.

The Secretary-Treasurer presented some correspondence with Mr. Cloyd M. Chapman and Mr. Hermann von Schrenk, Chairman of Committee D-7 on Standard Specifications for the Grading of Structural Timber. It was decided to instruct Committee D-7 to enlarge its membership with a special view of taking up, through a sub-committee, the question of the preservation of timbers. The Secretary-Treasurer was directed to notify every member of Committee D-7 of this action, coupled with the recommendation that a meeting of Committee D-7 be held at an early convenient date, and that a progress report be presented by this committee at the next annual meeting of the Society.

The question of a suitable form of announcement as to the conditions under which the cooperation of certain government bureaus with the work of technical committees might be enlisted was then considered, this question having previously been referred to a committee consisting of the President, Mr. S. W. Stratton and the Secretary-Treasurer.

There was presented on behalf of this committee an announcement proposed by the Bureau of Standards, and correspondence with other government bureaus. It was decided to instruct the Secretary-Treasurer to incorporate in an early circular to members such announcements as may be furnished for that purpose by the various government bureaus concerned.

The Secretary-Treasurer reported that the changes in the Regulations Governing Technical Committees, proposed by the Executive Committee (see minutes of previous meeting), and referred to Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, had been

approved at a meeting of that committee, but that the approval of the proposed change in the section on "Reports" had been coupled with the recommendation to the Executive Committee:

"That the Secretary-Treasurer of the Society be instructed to advise the Secretary or Chairman of every committee that a literal compliance with the provisions of this section in advance of the presentation of the report may be waived, under very exceptional circumstances, and on the recommendation of the committee concerned; in such a case, for example, where it should be found that a voluminous report cannot be printed in time for advance distribution among the members of the Committee."

On motion the above recommendation on the part of Committee E-5 was approved.

The Secretary-Treasurer presented the following changes in the Regulations Governing Technical Committees, proposed by Committee E-5:

Section on "Appointments," paragraph 1. Strike out:

"Unattached experts shall be classed with the representatives of non-producing interests."

and add the following new sentence:

"The classification of a committee as to producers and non-producers shall be determined by the committee."

Section on "Specifications:"

Introduce the following sentence in the first paragraph following the sentence closing with the words "on letter ballot of the entire committee:"

"The results of each letter ballot as to the number of affirmative votes, the number of negative votes, and the number of members not voting shall be announced in the report of the committee to the Society."

Add the following section on "Election of Officers" following the present section on "Permanent Organization:"

"*Election of Officers.*—Every technical committee shall hold an election of officers at or before the 1914 annual meeting of the Society. The term of office of every officer shall be two years and officers shall be eligible for re-election."

These proposed changes were approved with the exception of the addition of the new sentence "The classification of a committee as to producers and non-producers shall be determined by the committee," on which action was deferred pending the consideration of the following proposed changes, which includes the sentence in question:

Section on "Appointments." Proposed new paragraphs:

"2. The classification of the members of a committee into producers and non-producers shall be left to each committee, subject to the following

provisions, and with the understanding that a member dissatisfied with his classification has the right of appeal to the Executive Committee:

"(*a*) A member who stands in the relation of producer to any product within the province of the committee shall be classed as a producer, although at the request of the officers of the committee concerned, attention shall be called to the status of such members in a footnote worded as follows:

"These members of Committee....., classed as PRODUCERS, stand in the relation of PRODUCERS to certain products, and in that of NON-PRODUCERS to other products within the province of the committee.

"(*b*) A nominally unattached expert, who is permanently retained by producing interests in the field of activities of the committee with which he is connected, shall be classed as a producer.

"3. Only one representative from a given firm, company, corporation, laboratory, or other institution shall be eligible on a given committee, but if that membership is held in the name of the firm, company, corporation, laboratory, or other institution, more than one representative may, at the discretion of the committee concerned, participate in its activities, with the understanding that such representatives shall jointly command only a single vote. In the case of corporations or government branches whose policy does not admit of their holding membership in the Society under their corporate or official name, an exception to this rule may be permitted at the discretion of the committee concerned."

(Change present paragraph numbers 2 and 3 to 4 and 5.)

It was decided to approve these proposed changes provisionally and to refer them to Committee E-5, with the understanding that this action will not be considered final pending the consideration of the report of Committee E-5 to the Executive Committee.

The Secretary-Treasurer reported on behalf of Committee E-5, which had been charged by the Executive Committee to report "on desirable changes, if any, in the present methods of amending and adopting committee reports and specifications," that this subject had been fully discussed at a meeting of Committee E-5 and that it had been decided "to recommend no change in the present methods of the Society relative to the adoption of Standard Specifications, Definitions and Methods."

The Secretary-Treasurer was instructed to provide three columns in future letter ballots of the Society on the adoption of Standards, for affirmative, negative and non-voting records, and to call attention in connection with such ballots to the desirability that members who may not feel qualified to pass expert judgment on any parts of the matter submitted to vote should refrain from voting on these particular parts.

The following action was taken as to the nomination of American representatives on various International committees, subject to the approval of Captain Robert W. Hunt, the American representative on the Council of the International Association, who, being present at the meeting, gave such approval verbally:

On Committee 32 on Accelerated Tests of the Constancy of Volume of Cements:

R. L. Humphrey; Ernest Ashton; S. S. Voorhees, with the recommendation that R. L. Humphrey be made chairman of this committee.

On Committee 51 on Examination into the Desirability of Making Wood Tests on Larger Pieces Containing Defects or Variations in Structural Form Instead of Limiting the Tests to Small Perfect Pieces:

J. A. Newlin.

On Committee 55 on Effect of SO_3 in Portland Cement:

J. B. Lober; Clifford Richardson.

On Committee 56 on Fireproof Building Construction:

R. L. Humphrey; C. L. Norton;
R. P. Miller; I. H. Woolson.

On Committee 26 on Collection of Data which Permit the Ascertaining of Relations between the Properties Revealed by Impact Tests on Notched Bars, and the Behavior of the Pieces in Service. Comparison of Results Obtained with Various Apparatus:

R. P. Devries.

On Committee 7 on Weathering Qualities of Building Stone and Roofing Slates. Influence of Smoke, especially Sulfuric Acid, on Building Stones:

A. V. Bleininger.

On Committee 50 on the Influence of the Composition of Mortar and the Quality of Building Stones on the Weathering of the Masonry:

W. H. Powell.

The Secretary-Treasurer reported the appointment by the President of the following Finance Committee, in pursuance of action at the last meeting of the Executive Committee:

J. B. Lober, Chairman; F. H. Clark; A. W. Gibbs.

The Secretary-Treasurer presented two samples and two cost estimates for a proposed engraved certificate of membership in the Society. On motion the Secretary-Treasurer was authorized to have a certificate engraved on approval of the cost estimate by the Finance Committee.

It was decided to appoint the following nominating committee on prospective vacancies on the Executive Committee at the close of current terms of office, with instructions to report their nominations to the Executive Committee by the middle of April, and with the understanding that the traveling expenses of the members of this committee will be assumed by the Society:

Mansfield Merriman, Chairman, New York; H. M. Howe, Bedford Hills, N. Y.; R. W. Hunt, Chicago, Ill.; H. H. Quimby, Philadelphia, Pa.; Mont Schuyler, St. Louis, Mo.; R. J. Wig, Washington, D. C.; C. D. Young, Altoona, Pa.

The President was authorized to fill vacancies that might arise through the non-acceptance of any of the appointees on this committee.

REGULAR MEETING, April 24, 1914.—Engineers' Club, Philadelphia. Present: Mr. A. W. Gibbs, Vice-President; General W. H. Bixby, Mr. John Brunner, Mr. F. H. Clark, and Mr. A. A. Stevenson, Members of Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 84 applications for membership; that the Society had suffered the loss by death of 5 members; that 12 members had resigned; and that 79 members had been dropped for non-payment of dues, making the total members in the Society on April 1, 1610.

The Secretary-Treasurer reported that Committee A-7 on the Tempering and Testing of Steel Springs, was without a chairman owing to the resignation of Mr. Henry Souther before provision had been made for his successor. In the course of the discussion attention was called to the existence of Sub-Committee IV on Spring Steel, of Committee A-1 on Standard Specifications for Steel, and to the comparative inactivity of Committee A-7 throughout its existence of some eight years.

The Secretary-Treasurer was accordingly instructed to communicate with the members of Committee A-7 to the effect that it seems desirable to the Executive Committee that the consideration of steel springs should be merged with that of spring steel, and assigned to Sub-Committee IV of Committee A-1, with the understanding that if two-thirds of the voting members of Committee A-7 should favor this proposal such members of that committee as may be able and willing to participate actively in this work in the future will be recommended for appointment on Committee A-1 and Sub-Committee IV.

The Secretary-Treasurer presented some correspondence with Mr. J. J. Shuman in which he recommended that the business or professional affiliation of the various members of the technical committees be indicated in connection with their names in the personnel of such committees.

It was decided that this matter be referred to Committee E-5 with instructions to report their recommendations to the Executive Committee.

The Secretary-Treasurer presented the following recommendation on behalf of Committee E-6 on Papers and Publications:

"It is recommended to the Executive Committee to call the attention of the technical committees to the desirability of formulating proposed standard definitions of terms in matters which fall in their respective fields, and that in the case of terms which come within the province of two or more committees, such definitions be formulated by joint action through sub-committees on the part of the committees concerned.

"It is further recommended that as soon as the number of standard definitions should appear to warrant such action, an alphabetical glossary of the terms and their definitions be published in the Year-Book."

On motion these recommendations were approved and the Secretary-Treasurer was instructed to bring them to the notice of the various technical committees.

The sub-committee consisting of Mr. A. A. Stevenson, Mr. A. W. Gibbs and Mr. J. B. Lober, appointed to consider whether the subject of Standard Tests of Concrete and Concrete Aggregates should be referred to the existing Committee C-2 on Reinforced Concrete, or to a new committee, presented a report recommending that a new committee on this subject be appointed.

On motion this report was approved with the understanding that the

appointments on this committee shall be left with power to the President and Secretary-Treasurer.

The Secretary-Treasurer reported that the proposed new paragraphs 2 and 3, in the section on "Appointments" in the Regulations Governing Technical Committees, which the Executive Committee had referred to Committee E-5 on Regulations Governing the Form but not the Substance of Specifications, with the understanding that the report of that committee should be brought to the notice of the Executive Committee before its action was considered final, that Committee E-5 had approved these proposed changes. The provisional approval of these changes at the last meeting of the Executive Committee was accordingly made final.

The Secretary-Treasurer recommended the following addition to the present Regulations Governing Technical Committees:

American Representation on Committees of The International Association for Testing Materials.

Nominations.—In making nominations for appointment of American members on International committees on a subject falling within the province of an American technical committee, the sense of the latter committee as to the selection of the nominee shall be obtained before final action on the part of the Executive Committee.

Relation between American Representatives on International Committees and American Committees on the same subjects.—The American representative or representatives on an International committee dealing with subjects falling within the province of an American technical committee shall keep that committee fully advised as to important developments in the work of the International committee. Formal recommendations to the International committee on the part of such representative or representatives, and their vote on letter ballot of that committee shall be subject to advance approval on the part of the American committee.

On motion this recommendation was approved with the understanding that it will take its usual course in being referred to Committee E-5 on Regulations Governing the Form but not the Substance of Specifications.

The Secretary-Treasurer announced the following appointments on International committees, in pursuance of previous action on the part of the Executive Committee:

On Sub-Committee (of Committee 41 on Investigation of Reinforced Concrete) for the collection of statistics of accidents on reinforced-concrete buildings:

W. B. Fuller; R. P. Miller; S. E. Thompson.

On Committee 1b on Cast Iron and Cast-Iron Products, appointed especially with a view of serving on a sub-committee for the solution of chemical questions:

W. F. Hillebrand.

On Committee 58 on the Unification of the Methods of Testing Materials for Roads and of the Nomenclature of such Materials:

A. H. Blanchard; Prévost Hubbard.

And the following appointments, made by the President since the last meeting of the Executive Committee, subject to the approval of that committee:

On Committee 42 on Uniform Tests of Hydraulic Cements by Prisms, and Determination of a Standard Sand:

A. T. Goldbeck; R. S. Greenman.

On motion these appointments were approved.

The Secretary-Treasurer recommended that, in accordance with similar action on the part of other national bodies affiliated with the International Association, the American Society apply for membership as a body in that Association, and that an annual subscription of 100 francs be made in support of that membership.

On motion this recommendation was approved.

The Secretary-Treasurer presented a sample of the previously authorized certificate of membership in the Society. It was decided to call the attention of the members to this certificate and to announce that copies may be obtained at the following prices: On parchment skin, $2.50; on parchment paper, $2.00.

The Secretary-Treasurer presented the report of the Nominating Committee to the effect that at a meeting attended by Mr. Mansfield Merriman, Chairman, and Messrs. J. H. Gibboney, H. H. Quimby, Mont Schuyler, G. W. Thompson and Rudolph J. Wig,—Mr. Robert W. Hunt being absent for imperative reasons,—the following nominations were made, and that the acceptance of each nominee had been received.

For *President:* A. W. Gibbs.
For *Vice-President:* A. A. Stevenson.
For *Secretary-Treasurer:* Edgar Marburg.
For *Members of Executive Committee:*

Robert Job	A. Marston
F. W. Kelley	S. S. Voorhees.

The Secretary-Treasurer presented the proposed provisional program for the annual meeting in proof form, and it was approved with the understanding that it involved changes in dates from June 30–July 4 to June 30–July 3, in order to avoid a Saturday forenoon session on the 4th of July.

The recommendation of the Secretary-Treasurer that Mr. Anderson Polk be again appointed to the chairmanship of the Entertainment Committee was approved. Further appointments on this committee were left with power to Mr. Polk and the Secretary-Treasurer.

APPENDIX II.

BY-LAWS REVISED AS PROPOSED BY THE EXECUTIVE COMMITTEE.

ARTICLE I.

MEMBERS *AND THEIR ELECTION*.

SECTION 1. The Society shall consist of Members, Junior Members and Honorary Members.

SEC. 2. A Member shall be a person not less than thirty years of age, *or a* corporation, *a* firm, *a* technical *or scientific* society, *a* teaching faculty, or *a* library, proposed by two members and ~~approved~~ *elected* by the Executive Committee.

SEC. 3. A Junior Member shall be a person less than thirty years of age on the date of his admission, proposed by two members and ~~approved~~ *elected* by the Executive Committee.

A Junior Member shall have the same rights and privileges as a Member, and his status shall be changed from that of Junior Member to Member at the beginning of the fiscal year next succeeding the date on which he attains the age of thirty years.

SEC. 4. An Honorary Member shall be a person of widely recognized eminence in some part of the field which the Society aims to cover as defined in ~~Paragraph~~ *Section* 2 of the Charter. The number of Honorary Members shall not exceed ten. A nominee for honorary membership shall be proposed by at least ten members. ~~and~~ *He* shall be elected only by unanimous vote of the Executive Committee *on letter ballot. Such a ballot shall be authorized only by unanimous vote of the officers present at the meeting at which the nomination is presented.*

SEC. 5. Applications for membership and resignations from membership must be transmitted in writing to the Secretary-*Treasurer.*

ARTICLE II.

OFFICERS AND THEIR ELECTION.

SECTION 1. The officers shall be a President, a First Vice-President, a Second Vice-President, and a Secretary Treasurer.

SEC. 2. These officers shall be elected by letter ballot at the Annual Meetings. The President shall hold office for one year. The two Vice-Presidents and the Secretary Treasurer shall hold office for two years. The term of office of the First Vice-President and of the Secretary Treasurer shall expire in the even years, and that of the Second Vice-President in the odd years.

SEC. 3. The Executive Committee shall consist of these officers and eight members, four being elected by letter ballot at each Annual Meeting. Four members of the Executive Committee shall constitute a quorum.

SEC. 4. The President, the two Vice-Presidents and the members of the Executive Committee shall be ineligible for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

SEC. 5. The Secretary shall receive a salary to be fixed by the Executive Committee.

SEC. 6. The officers and members of the Executive Committee shall serve for the respective terms to which they shall have been elected, or until their successors shall have been duly elected.

SEC. 7. The Executive Committee shall have the power to fill any vacancies occurring in their number by death, resignation or otherwise.

SEC. 8. The election of officers and members of the Executive Committee shall be by letter ballot. The Executive Committee, before each Annual Meeting, shall appoint a Nominating Committee, whose duty it shall be to nominate a full list of officers. The list of nominations so made shall be submitted to the membership not more than eight (8) nor less than four (4) weeks before the coming Annual Meeting.

Further nominations, signed by at least ten (10) members, may be submitted to the Secretary in writing at least four (4)

~~weeks before the Annual Meeting, and such nominations shall also be submitted to the membership on the official ballot.~~

SECTION 1. The officers shall be a President, two Vice-Presidents, a Secretary-Treasurer, and eight Members of Executive Committee.

SEC. 2. The Executive Committee shall consist of these twelve officers and the last three Past-Presidents.

SEC. 3. The officers—with the exception of the Secretary-Treasurer—shall be elected by letter ballot of the Society. The letter ballot shall close at noon on the day preceding the opening of the Annual Meeting, and the result of the ballot shall be announced at the close of the first session of the Annual Meeting. The terms of office shall begin at the time of this announcement, except that the retiring President shall continue as presiding officer of the sessions of the Society throughout the Annual Meeting. The President-elect shall be the presiding officer at any session of the Executive Committee that may be held after the announcement of his election.

SEC. 4. The President shall hold office for one year. The two Vice-Presidents and the Members of Executive Committee shall hold office for two years. The terms of office of one Vice-President and four Members of Executive Committee shall expire in the even years, and those of one Vice-President and four Members of Executive Committee in the odd years.

SEC. 5. The Secretary-Treasurer shall be elected annually by the Executive Committee at the first meeting following the announcement of elections. He shall receive a salary fixed by the Executive Committee.

SEC. 6. The President, the two Vice-Presidents and the Members of Executive Committee shall be ineligible for re-election to the same office until at least one term shall have elapsed after the end of their respective terms.

SEC. 7. The officers shall serve for the respective terms to which they shall have been elected, or until their successors shall have been elected.

SEC. 8. The Executive Committee shall have the power to fill any vacancies occurring in their number by death, resignation or otherwise.

ARTICLE III.

NOMINATION OF OFFICERS.

SECTION 1. There shall be created annually a nominating committee consisting of the last three Past-Presidents of the Society and six other members appointed by the Executive Committee.

SEC. 2. Within five days after December 1 of each year the Secretary-Treasurer shall notify every member of the Society that he has the right to recommend two members for appointment on the nominating committee. A committee of tellers appointed by the President shall canvass the recommendations which have been received by the Secretary-Treasurer prior to January 1, and shall transmit the returns to the Secretary-Treasurer in time for presentation to the Executive Committee at its January quarterly meeting. At that meeting the Executive Committee shall consider the recommendations of the members with due reference to the various interests in the Society, and shall then appoint six members of the nominating committee and one alternate for each of these members. The Secretary-Treasurer shall notify the members and the alternates of their appointments and of the date and place of meeting of the nominating committee. In case the Secretary-Treasurer does not receive from any member of the nominating committee within 15 days of the date of sending out notification a statement that it is the purpose of this member to attend the meeting of the nominating committee, he shall so inform the alternate of this member.

SEC. 3. The meeting of the nominating committee shall be held at such time in the month of March and at such place as shall be determined by the Executive Committee. The traveling expenses of the members of the nominating committee shall be defrayed by the Society. It shall be the duty of the nominating committee to make one nomination for each office, except that of Secretary-Treasurer, for which the term will expire at the time of the next Annual Meeting. Only members of the nominating committee who are in attendance at the meeting may participate in the work of the committee, but an alternate who is present may take the place of the member he is appointed to represent.

SEC. 4. The Secretary-Treasurer shall notify each nominee of his nomination. In case a nomination is declined or in case

the person nominated is ineligible, the Executive Committee shall fill the vacant place in the list of nominations. The nominations shall be announced to the members through a notice issued during the last week in April.

SEC. 5. Further nominations, signed by at least 25 members, may be submitted to the Secretary-Treasurer in writing by May 20, and a nomination so made, if accepted by the member nominated, shall be placed on the official ballot.

SEC. 6. An official ballot shall be issued to the members between May 20 and June 1, which ballot shall contain names of nominees made according to the provisions of this Article.

SEC. 7. The dates in this Article are fixed on the assumption that the Annual Meeting will be held between the middle of June and the middle of July. If this meeting should be held outside of this period the Executive Committee shall be authorized to depart from the dates in this Article as may seem expedient, consistent with the general spirit and purpose of the provisions in this Article.

ARTICLE IV.

DUTIES OF OFFICERS.

SECTION 1. The general management of the Society shall be vested in the Executive Committee.

The Executive Committee shall hold regular meetings quarterly during the year. The time and place at which such meetings shall be held shall be fixed by the Executive Committee.

Special meetings of the Executive Committee shall be held at the direction of the President, or upon request in writing to the President of five or more officers.

Five members of the Executive Committee shall constitute a quorum.

SEC. 2. The President shall preside at all meetings of the Society (except as restricted in Article II, Section 3) and of the Executive Committee. He may appoint any other officer or member of the Society to preside at any designated session of the Annual Meeting. He shall be a member ex-officio of every committee of the Society.

SEC. 3. In the absence of the President the duties shall be performed by the senior Vice-President present. In the absence

of the President and Vice-Presidents, the duties of the President shall be performed by a President pro tem., elected by the Executive Committee.

SEC. 4. The Secretary-Treasurer shall be charged with such duties as the Executive Committee may determine.

ARTICLE ~~III~~ *V.*

MEETINGS.

SECTION 1. The Society shall meet annually *at a* ~~The~~ time and place ~~of each meeting shall be~~ fixed by the Executive Committee. *Twenty-five members shall constitute a quorum.*

SEC. 2. Special meetings may be called whenever the Executive Committee shall deem it necessary, or upon the ~~request in writing to the President of twenty five (25) members~~. *written request of 25 members to the President.*

ARTICLE ~~IV~~ *VI.*

PROCEDURE GOVERNING THE ADOPTION OF STANDARD SPECIFICATIONS, *DEFINITIONS OR METHODS.*

SECTION 1. ~~A~~ Proposed standard specifications, *definitions or methods* must be presented at the Annual Meeting ~~at~~ At ~~which it may be amended by majority vote of those voting~~ *this meeting amendments may be made by a two-thirds vote of those voting.* A two-thirds ~~affirmative~~ vote of those voting shall be required to refer the *proposed standard* specifications, *definitions or methods* to letter ballot of the Society. A two-thirds ~~affirmative~~ vote of those voting on letter ballot shall be required for the adoption of the *proposed standard* specifications, *definitions or methods.*

ARTICLE ~~V~~ *VII.*

DUES.

SECTION 1. The fiscal year shall commence on the first of January. The annual dues shall be $10 for Members and $5 for Junior Members, payable in advance. Honorary Members shall not be subject to dues.

SEC. 2. Members or Junior Members holding membership also in the International Association for Testing Materials shall pay annually, in advance, the additional sum of $4, the fiscal year of the International Association beginning on the first of January, which sum shall be transmitted by the *Secretary*-Treasurer to the International Association.

SEC. 3. Any Member or Junior Member may compound his dues at the beginning of any fiscal year by the purchase of a life membership, exempting him for life from annual dues, by the payment of the sum of one hundred and fifty dollars ($150); provided such membership is held by an individual. The cost of life membership, or membership in perpetuity, to corporations, firms, technical *or scientific* societies, teaching faculties, or libraries shall be two hundred dollars ($200).

SEC. 4. Any member of the Society whose dues shall remain unpaid for a period of three months from the beginning of the fiscal year shall receive a "Second Notice" from the *Secretary*-Treasurer; if his dues shall remain unpaid for a period of five months from the beginning of the fiscal year, he shall forfeit the right to vote and to receive the publications of the Society. A month before the close of the fiscal year, he shall receive a final notice from the *Secretary*-Treasurer that, if he neglects to pay his dues before the end of the fiscal year, his name may be stricken from the roll of membership by the Executive Committee.

SEC. 5. Any person elected after six months of any fiscal year shall have expired, ~~shall~~ *may* pay only one-half of the amount of dues for that fiscal year; but *in that case* he shall not be entitled to a copy of the Proceedings ~~of~~ *for* the ~~previous~~ *current* ~~Annual Meeting~~ *year*.

ARTICLE ~~VI~~ *VIII*.

RESIGNATIONS.

SECTION 1. The resignation of a member whose dues for the current fiscal year are unpaid, shall be acceptable only if it be received within one month from the beginning of the fiscal year, unless an exception be authorized by special action of the Executive Committee

ARTICLE ~~VII~~ *IX*.

AMENDMENTS.

SECTION 1. Proposed amendments to these By-Laws, signed by at least ~~three~~ *ten* members, must be presented in writing to the Executive Committee at least four weeks before the next Annual Meeting. In the notices for this meeting the proposed amendments shall be printed. At the Annual Meeting the proposed amendments may be discussed and amended and may be passed to letter ballot by a two-thirds vote of those present.

If two-thirds of the votes obtained by letter ballot are in favor of the proposed amendments, ~~it~~ *they* shall be adopted.

SEC. 2. The Executive Committee is authorized to number the Articles and Sections of the By-Laws to correspond with any changes that may be made.

REPORT ON PROCEEDINGS OF TURIN MEETING OF THE COUNCIL OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.[1]

By Henry M. Howe, Life Member of Council.

The 1915 St. Petersburg Congress of The International Association for Testing Materials will open with a reception on the evening of Wednesday, August 11, and last six days till the afternoon of Tuesday, August 17, with six sectional sessions on four days, four excursions or visits by day, and four evening entertainments. The sessions will thus be broken by Sunday, on which there will be the banquet and a visit to Peterhof.

A few hours after the final general session three independent excursions will start simultaneously, one to Finland, one to Warsaw, perhaps en route for home, and one to Moscow, with a prolongation for a limited number to the Caucasus.

The most important work of the Turin meeting was with regard to international specifications. Chairman Brügman of Committee 1(*b*) on International Specifications for Cast Iron, reported by letter that the American and German members had agreed on a basis for grading pig iron by analysis, on the unification of the test bar, and on export specifications for cast-iron pipes. The British members had offered an alternative for the first, had agreed in principle to the second, reserving the right to offer amendments in detail, and had not agreed to the third. The Council invited the Committee "to continue its activity." This action seemed in effect to put the Council on record as approving the active preparation of international specifications. A resolution was offered, intended to leave no shadow of doubt as to the Council's position. It was as follows:

"The Council of the International Association for Testing Materials welcomes the preparation of standard specifications for the delivery of materials of construction intended for international trading purposes.

[1] This meeting was held in April, 1914.

"The Council fully realizes the difficulties attending any attempt to unify existing specifications of the countries adhering to the Association, but sees in the agreement upon standard specifications for export purposes, a distinct advance in international efficiency and comity.

"The Council asks a full discussion and trial of the standard specifications so far presented, so that, if possible, final action be taken at the St. Petersburg Congress. The Council also hopes to receive further proposals, and requests that each country may stimulate the industries towards early action in the direction of standard specifications for international trading purposes, in conjunction with the other producing countries."

This resolution was supported by some of the most influential members present, including the presiding officer, General Director Greiner of Seraing, and Vice-President Mesnager. It was passed unanimously and according to my understanding without opposition.

Next in importance and even more difficult was the work of regulating the manning of committees. Experience showed that the existing arrangements needed change. In the past large unwieldy committees, many of whose members were uninterested and neglected their duties, had made the chairmanship of these committees most trying. It was contended that, because of the great specialization, a man fitted for the chairmanship of a committee probably knew better who the most suitable man in any given country was, especially in the large countries, than the member of Council for that country. Hence it was better that the chairman should select the various members, but that as a check his selection from a given country must needs have the approval of the member of Council from that country. The new rules for committees were made in accordance with this opinion, and with many important provisions, such as that members cannot be added to a committee between Council meetings except with the consent of the chairman of the committee, and that committees which fail to show, at any congress, the need of their further activity are to be dissolved as a matter of regular procedure.

More than one country has a highly organized national society, and it was recognized that such societies can select the best committee-men even better than the chairman of the committee itself. The difficulty was to provide by statute for these exceptional cases, while permitting the chairman of a given

committee to select his own cabinet from other countries. This difficulty was met by empowering the General Secretary "to draw the attention of the chairmen of committees, when inviting them to take office, to the special circumstances of certain countries, which render it desirable that proposals for members of committees from these countries should be made by the member of Council or the Executive Committee in question."

The remaining matters of special interest to the American Society are the appointment of the American Member of Council, Capt. R. W. Hunt, as Vice-President; the appointment of an Executive Committee to carry on matters between Council meetings; and the recognition of the importance of the propaganda. In effect, the great purpose of the International Association for Testing Materials is to substitute knowledge for faith, to enable mankind to judge the fitness of its purchases intelligently, and to that end to increase and spread knowledge as to the properties which those purchases ought to have, and the methods by which the presence or absence of those properties can be determined. This purpose, while it is well served by the triennial congresses, yet is capable of being served even better by the creation, in the various countries, of societies like that which I now have the honor of addressing. Many of the interests in this country as well as in others which are benefited by the existence of this society will be benefited in like manner by the creation of like societies elsewhere, by their enabling purchasers in other countries to rely on their own tests rather than on faith.

DISCUSSION.

Mr. A. A. Stevenson. Mr. Stevenson.

Mr. A. A. Stevenson.—I should like to ask Mr. Howe whether the resolution adopted by the council puts International Committee 1(a) in position to take any action whatever?

Mr. Henry M. Howe. Mr. Howe.

Mr. Henry M. Howe.—The action of the Council I interpret as approving the action of the committee in preparing proposed international specifications, and as recommending that it continue this work. This interpretation is supported by the fact that so important and competent a man as Mr. Schroedter, of Düsseldorf, has been put in charge of the committee. I do not know of anybody who is more competent to carry the work of a committee on international specifications to an effective, fruitful conclusion. He is by no means a visionary or a dreamer, but a hard-headed, competent man of affairs. He occupies a very important position with regard to the German iron industry. I believe he has for many years been the Secretary of the Society of German Iron Masters, and is of very great influence, very high standing, recognized all over the world, I suppose, as extremely eminent. He is fitted particularly well for this position. His appointment I interpret as meaning that the committee is going to do far more than talk about international specifications and find excuses for not making substantial progress towards their actual adoption.

Mr. Richard Moldenke. Mr. Moldenke.

Mr. Richard Moldenke.—May I supplement what Mr. Howe has said by urging the American committee members interested in steel, cement, and other materials of construction, to do as we of the Committee on Cast Iron have done; namely, to cross the ocean and become active in formulating proposed Standard International Export Specifications?

REPORT OF COMMITTEE A-1

ON

STANDARD SPECIFICATIONS FOR STEEL.

The past year has been an extremely active one in the affairs of Committee A-1. Before presenting its formal recommendations to the Society, the committee desires to call attention to several general matters believed to be of sufficient importance to warrant comment.

Regulations Governing Committee A-1.—The large and growing personnel of the committee, the creation of sub-committees on new subjects, and the increasing number of specifications in the charge of the committee,—at present there are 30 such specifications, or nearly one-half of the total of 64 issued by the Society,—has shown the necessity of conducting the increasing work of the committee under broad regulations designed to systematize the routine work so far as possible, without restricting in any way the freedom of action of the committee or its sub-committees. Accordingly, the committee has drawn up and adopted the Regulations Governing Committee A-1, attached to this report as Appendix I. These Regulations are, of course, supplementary to the Regulations Governing Technical Committees, and provide, in brief, for the creation of an Advisory Committee composed of the chairmen of sub-committees, in which is vested the executive direction of the committee; for the biennial election of officers—a chairman, two vice-chairmen and a secretary; for meetings of the committee and its sub-committees; for attendance at meetings; and, finally, contain instructions to sub-committees in the matters of drafting of specifications, presentation of reports, etc.

Two meetings of the committee have been held since these Regulations were adopted; and it is confidently anticipated that the affairs of the committee will be conducted in the future with greater smoothness than would otherwise be possible.

The committee has recommended to the Executive Committee that the Regulations Governing Committee A-1 shall be published in the Year-Book of the Society.

Membership.—The membership of the committee has been increased from 93, at the last annual meeting, to 108, comprising 71 non-producers and 37 producers. Of this number, at least one-half have been actively engaged in the affairs of the committee during the past year, while approximately one-fourth have been absent from two successive meetings without excuse and may therefore be dropped from membership as provided in the Regulations Governing Committee A–1.

Sub-Committees—There are now 15 sub-committees of Committee A-1, including the Advisory Committee. The following important changes in sub-committees have been made during the past year:

The three former sub-committees on Axles, on Forgings, and on Blooms, Billets and Slabs, have been merged into a new Sub-Committee VI on Forgings, to which have been added members of the former Sub-Committee on Locomotive Materials interested in forgings. In addition, several members of the Society have been invited to membership on Committee A-1 to secure their services on this sub-committee.

The former Sub-Committee on Locomotive Materials has been changed to Sub-Committee XI on Boiler Steel, forgings and structural steel for locomotives being placed in the charge of the sub-committees on forgings and structural steel, respectively, and the title of the latter sub-committee changed to "Sub-Committee II on Structural Steel for Bridges, Buildings and Rolling Stock."

A new Sub-Committee XIII on Methods of Physical Tests has been created. A special sub-committee, consisting of representatives of locomotive builders and the railroads, was appointed to report as to which of the standard specifications for steel should be recommended by the committee for use in locomotive construction.

Meetings.—Since the last annual meeting, Committee A-1 has held three meetings covering eight sessions, with an average attendance at each meeting of 46 individuals, representing 40 members. At the last two meetings, which were held after the Regulations Governing Committee A-1 had become operative, 28 members gave written excuses for absence. At the last meeting of the committee, covering four sessions, 58 members,

or over half of the total membership of 108, were present or absent with excuse.

The sub-committees have also been very active. The Advisory Committee has held four well-attended meetings. There have been held during the year 24 sub-committee meetings, with an estimated total attendance of 250 members and invited guests.

Possibly the most important single recommendation of the committee in this report is with reference to the revision of the forgings specifications. In order that the members of the Society at large may understand how thoroughly the work of revising these specifications has been done, the committee desires to present the following data with reference to the work of Sub-Committee VI on Forgings: This sub-committee, consisting of 31 members, has held six meetings, with an average attendance of 27 members and invited guests; the average attendance of members was 22, or over two-thirds of the total membership. At two of the six meetings there was an even balance between non-producers and producers; at four, the non-producers were in the majority. Two of the six meetings covered two days; including evening sessions, practically $9\frac{1}{2}$ days have been spent by the sub-committee in revising the forging specifications. In addition, six sub-sub-committees have been appointed to consider various features of the specifications, and have held a number of meetings. Minutes of the meetings have been sent to each member of the sub-committee, while the reports of the sub-committee to Committee A-1 have been distributed to the entire membership. The reports of the sub-committee to Committee A-1 were carefully considered at two well-attended meetings of Committee A-1, and the recommendations of the sub-committee were approved with substantial unanimity.

In view of the careful, painstaking work of its various sub-committees, the committee earnestly solicits the support of the Society in the recommendations contained in this report.

Recommendations.—The matters which the committee recommends shall be referred to letter ballot of the Society, which are given in more detail later in this report, may be summarized as follows: (1) That of the sixteen specifications distinguished in the following list by italics, the eleven marked (*)

be revised in accordance with the detailed recommendations contained in Appendix II of this report and the remaining five be cancelled and superseded by the four[1] proposed revised specifications whose titles are given in parentheses in the list and which are appended to this report;[2] (2) that the two proposed new standard specifications and the proposed new standard methods listed below and appended to this report[2] be adopted; and (3) that the recommendations relative to the position of fracture of 2 and 8-in. tension test specimens, contained under the sub-heading "Methods of Physical Tests" later in the report, be adopted.

The following is a complete list of the present standard and the proposed new specifications and methods:

PRESENT STANDARD SPECIFICATIONS.

1. *For Bessemer Steel Rails.*
2. *For Open-hearth Steel Rails.* } (For Carbon-Steel Rails.)
3. For Open-hearth Girder and High-Tee Rails.
4. **For Low-Carbon-Steel Splice Bars.*
5. **For Medium-Carbon-Steel Splice Bars.*
6. **For High-Carbon-Steel Splice Bars.*
7. **For Extra-High-Carbon-Steel Splice Bars.*
8. **For Structural Steel for Bridges.*
9. **For Structural Nickel Steel.*
10. **For Structural Steel for Buildings.*
11. **For Shapes, Universal Mill Plates and Bars for Locomotive Materials.*
12. For Structural Steel for Ships.
13. For Rivet Steel for Ships.
14. **For Billet-Steel Concrete Reinforcement Bars.*
15. For Rail-Steel Concrete Reinforcement Bars.
16. For Blooms, Billets and Slabs for Carbon-Steel Forgings.
17. *For Steel Forgings* (For Carbon-Steel and Alloy-Steel Forgings).

[1] The two present Standard Specifications for Bessemer Steel Rails and for Open-hearth Steel Rails will by this arrangement be replaced by one Specification for Carbon-Steel Rails.

[2] The specifications here referred to as appended to the report have not been printed in the *Proceedings*. They appear in the 1914 Year-Book.—ED.

* The proposed revisions in these specifications are contained in Appendix II.

PRESENT STANDARD SPECIFICATIONS (*Continued*).

18. *For Heat-Treated Carbon-Steel Axles, Shafts, and Similar Objects.* (For Quenched-and-Tempered Carbon-Steel Axles, Shafts and other Forgings for Locomotives and Cars).
19. *For Steel Forgings for Locomotives* (For Carbon-Steel Forgings for Locomotives).
20. **For Carbon-Steel Car and Tender Axles.*
21. **For Cold-Rolled Steel Axles.*
22. For Forged and Rolled, Forged, or Rolled Solid Carbon-Steel Wheels for Engine-Truck, Tender and Passenger Service.
23. For Forged and Rolled, Forged, or Rolled Solid Carbon-Steel Wheels for Freight-Car Service.
24. For Wrought Solid Carbon-Steel Wheels for Electric Railway Service.
25. For Steel Tires.
26. For Steel Castings.
27. For Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends, and Arch Tubes.
28. For Automobile Carbon and Alloy Steels.
29. For Boiler and Firebox Steel.
30. For Boiler Rivet Steel.

PROPOSED NEW STANDARD SPECIFICATIONS.

31. For Structural Steel for Cars.
32. For Carbon-Steel Bars for Springs.

PROPOSED NEW STANDARD METHODS.

33. Of Chemical Analysis for Plain Carbon Steel.

The results of the letter ballot of the committee on the above-mentioned recommendations to refer to letter ballot of the Society are given in the following table:

* The proposed revisions in these specifications are contained in Appendix II.

Items.	Affirmative.	Negative.	Not Voting.[1]
REVISIONS IN PRESENT STANDARD SPECIFICATIONS RECOMMENDED IN APPENDIX I:			
Low-Carbon-Steel Splice Bars	57	4	47
Medium-Carbon-Steel Splice Bars	56	6	46
High-Carbon-Steel Splice Bars	56	6	46
Extra-High-Carbon Steel Splice Bars	56	6	46
Structural Steel for Bridges	65	1	42
Structural Nickel Steel	60	1	47
Structural Steel for Buildings	65	0	43
Shapes, Universal Mill Plates and Bars for Locomotive Materials	60	1	47
Billet-Steel Concrete Reinforcement Bars	60	0	48
Carbon-Steel Car and Tender Axles	57	3	48
Cold-Rolled Steel Axles	52	0	56
PROPOSED REVISED STANDARD SPECIFICATIONS TO SUPERSEDE PRESENT STANDARD SPECIFICATIONS:			
Carbon-Steel Rails	47	14	47
Carbon-Steel and Alloy-Steel Forgings	66	1	41
Quenched-and-Tempered Carbon-Steel Axles, Shafts, and other Forgings for Locomotives and Cars	58	2	48
Carbon-Steel Forgings for Locomotives	62	0	46
PROPOSED NEW STANDARD SPECIFICATIONS AND METHODS:			
Structural Steel for Cars	62	3	43
Carbon-Steel Bars for Springs	57	5	46
Chemical Analysis for Plain Carbon Steel	67	0	41
MISCELLANEOUS.			
Recommendations relative to position of fracture of 2 and 8-in. tension test specimens	74	1	33
[2]Recommendation relative to permissible variations in weight and gage of sheared plates	50	14	44

Total Number of Ballots Cast 82
Number not voting 26
Total Membership 108

In the following the committee presents its recommendations in greater detail. Owing to the diversity of the subjects in the charge of the committee, it has been deemed best to group

[1] Of the 108 members of the committee, 26 failed to vote on any of the items listed. The remaining number marked "not voting"—that is, after subtracting 26 from each number in the last column—voted affirmatively or negatively on one or more of these items.

[2] As explained later, this recommendation was lost on letter ballot because there were more than 10 negative votes.

6. *Finish.*—A variation of $\frac{1}{32}$ in. larger than the specified size of holes is permitted by the proposed specifications.

7. The proposed specifications contain a paragraph rejecting all rails which show interior defect at either end or in any drilled hole. While the present specifications imply this, it is not specifically stated.

The proposed revised specifications are identical with those of the American Railway Engineering Association, except in the following features:

(*a*) Provision has been made for rails between 50 and 70 lb., and 100 and 120 lb. in weight.

(*b*) Rails adjoining test pieces which have shown the presence of interior defects are marked as special to be used at the discretion of the purchaser, instead of being rejected.

(*c*) A change has been made permitting the use of retest from the bottom of the top rail instead of the top of the second rail, and from the bottom of the second rail instead of the top of the third rail, in order to prevent destroying full-length rails. This change is an additional safeguard for the purchaser, as well as being desirable from the manufacturer's standpoint.

(*d*) In the case of rails over 100 lb. in weight, the distance between supports in the drop-testing machine has been increased to 4 ft., because it has been indicated by experiment that the shorter distance between supports results in a shearing action on the rails rather than a full opportunity to develop the ductility.

These specifications have not been revised as to form, with a view of facilitating comparison with the specifications of the American Railway Engineering Association.

Camber in Splice Bars.—At the last annual meeting, Committee A-1 was instructed to report upon the question of "the permissible camber in both planes, and its direction in a horizontal plane, for medium-carbon, high-carbon, and extra-high carbon-steel splice bars."[1] The recommendation of the committee on this question is given in Appendix II, to apply to all splice-bar specifications. The proposed requirement differs somewhat from the present requirement of the American Electric Railway Engineering Association, and will be submitted to that association with a recommendation for its adoption.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).

Further recommended changes in the tensile requirements for medium-carbon-steel splice bars, and in the permissible variation in the location of holes for medium, high and extra-high-carbon-steel splice bars, are contained in Appendix II.

Heat-Treated Splice Bars and Bolts.—Sub-Committee I has under consideration the preparation of specifications for heat-treated splice bars and bolts.

STRUCTURAL STEEL FOR BRIDGES, BUILDINGS AND ROLLING STOCK (SUB-COMMITTEE II).

Proposed New Specifications for Structural Steel for Cars.—These specifications, appended hereto[1] and recommended for adoption by the Society, have been modeled upon the present standard specifications for structural steel. They provide for shapes, plates and bars over $\frac{1}{8}$ in. in thickness, with a range in tensile strength from 50,000 to 65,000 lb. per sq. in.

Proposed Revisions in Present Specifications for Structural Steel.—The revisions recommended in the present specifications for structural steel are listed in Appendix II. In presenting these revisions the committee desires to call attention to the following features:

Tensile Strength of Rivet Steel.—At the last annual meeting, Committee A-1 was instructed to report upon the question of "the reduction of the specified limit of the ultimate strength of rivet steel from 48,000-58,000 to 46,000–54,000 lb. per sq. in."[2] The recommendation of the committee, as contained in Appendix II, applies to the Specifications for Structural Steel for Bridges and for Buildings, and is to change the tensile strength to 46,000–56,000 lb. per sq. in.

Forgings in Specifications for Structural Steel.—The specifications for Structural Steel for Bridges, for Structural Nickel Steel, and for Structural Steel for Buildings, have been revised to eliminate definite reference to forgings, in order to harmonize the present specifications in this respect with the proposed revised specifications for forgings which the committee is recommending for adoption this year.

Eye Bars for Bridges.—The requirements for eye bars for bridges have been revised: (1) To include bend tests of un-

[1] See 1914 Year-Book, pp. 65–69.—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).

6. *Finish.*—A variation of $\frac{1}{32}$ in. larger than the specified size of holes is permitted by the proposed specifications.

7. The proposed specifications contain a paragraph rejecting all rails which show interior defect at either end or in any drilled hole. While the present specifications imply this, it is not specifically stated.

The proposed revised specifications are identical with those of the American Railway Engineering Association, except in the following features:

(*a*) Provision has been made for rails between 50 and 70 lb., and 100 and 120 lb. in weight.

(*b*) Rails adjoining test pieces which have shown the presence of interior defects are marked as special to be used at the discretion of the purchaser, instead of being rejected.

(*c*) A change has been made permitting the use of retest from the bottom of the top rail instead of the top of the second rail, and from the bottom of the second rail instead of the top of the third rail, in order to prevent destroying full-length rails. This change is an additional safeguard for the purchaser, as well as being desirable from the manufacturer's standpoint.

(*d*) In the case of rails over 100 lb. in weight, the distance between supports in the drop-testing machine has been increased to 4 ft., because it has been indicated by experiment that the shorter distance between supports results in a shearing action on the rails rather than a full opportunity to develop the ductility.

These specifications have not been revised as to form, with a view of facilitating comparison with the specifications of the American Railway Engineering Association.

Camber in Splice Bars.—At the last annual meeting, Committee A-1 was instructed to report upon the question of "the permissible camber in both planes, and its direction in a horizontal plane, for medium-carbon, high-carbon, and extra-high carbon-steel splice bars."[1] The recommendation of the committee on this question is given in Appendix II, to apply to all splice-bar specifications. The proposed requirement differs somewhat from the present requirement of the American Electric Railway Engineering Association, and will be submitted to that association with a recommendation for its adoption.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).

Further recommended changes in the tensile requirements for medium-carbon-steel splice bars, and in the permissible variation in the location of holes for medium, high and extra-high-carbon-steel splice bars, are contained in Appendix II.

Heat-Treated Splice Bars and Bolts.—Sub-Committee I has under consideration the preparation of specifications for heat-treated splice bars and bolts.

Structural Steel for Bridges, Buildings and Rolling Stock (Sub-Committee II).

Proposed New Specifications for Structural Steel for Cars.—These specifications, appended hereto[1] and recommended for adoption by the Society, have been modeled upon the present standard specifications for structural steel. They provide for shapes, plates and bars over $\frac{1}{8}$ in. in thickness, with a range in tensile strength from 50,000 to 65,000 lb. per sq. in.

Proposed Revisions in Present Specifications for Structural Steel.—The revisions recommended in the present specifications for structural steel are listed in Appendix II. In presenting these revisions the committee desires to call attention to the following features:

Tensile Strength of Rivet Steel.—At the last annual meeting, Committee A-1 was instructed to report upon the question of "the reduction of the specified limit of the ultimate strength of rivet steel from 48,000–58,000 to 46,000–54,000 lb. per sq. in."[2] The recommendation of the committee, as contained in Appendix II, applies to the Specifications for Structural Steel for Bridges and for Buildings, and is to change the tensile strength to 46,000–56,000 lb. per sq. in.

Forgings in Specifications for Structural Steel.—The specifications for Structural Steel for Bridges, for Structural Nickel Steel, and for Structural Steel for Buildings, have been revised to eliminate definite reference to forgings, in order to harmonize the present specifications in this respect with the proposed revised specifications for forgings which the committee is recommending for adoption this year.

Eye Bars for Bridges.—The requirements for eye bars for bridges have been revised: (1) To include bend tests of un-

[1] See 1914 Year-Book, pp. 65–69.—Ed.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).

annealed eye-bar flats; (2) To permit the purchaser to determine and specify the tensile strength to be obtained in specimen tests of the unannealed bars, up to a maximum of 74,000 lb. per sq. in., to meet the required minimum tensile strength of the full-size annealed eye-bars. This is in line with the practice followed in the Specifications for Steel Railway Bridges of the American Railway Engineering Association.

Tests of Angles.—The committee believes that these tests are unnecessary and very seldom called for, and therefore recommends that they be omitted from the specifications in which they occur.

Specifications for Structural Steel for Buildings.—The changes in Sections 7 and 8 of these specifications (see Appendix II) have been recommended to make these sections consistent with the proposed revised form of the corresponding sections of the Specifications for Structural Steel for Bridges.

Specifications for Shapes, Universal Mill Plates, and Bars for Locomotive Materials.—These specifications have been revised, as indicated in Appendix II, with a view of making them consistent as to form, and in part as to substance, with the proposed new Specifications for Structural Steel for Cars and, particularly, of providing for sheared plates; it being explicitly stated, however, that these specifications are not intended to apply to boiler and firebox plates.

SPRING STEEL (SUB-COMMITTEE IV).

Proposed New Specifications for Carbon-Steel Bars for Springs.[1] —In presenting these specifications[2] for adoption by the Society, the committee desires to state that the omission of a silicon requirement from the specifications is due to the fact that the presence of this element has not yet been conclusively shown to be essential or of definite value. In view of this and of the extra cost involved, it is considered that such a requirement should be included only in cases where it is desired.

Alloy Steels for Springs.—Sub-Committee IV has under consideration the preparation of specifications for alloy steels for springs.

[1] In presenting these specifications at the annual meeting, the committee recommended certain amendments, which are given on pp. 17–18.—ED.

[2] See 1914 Year-Book, pp. 80–82.—ED.

Steel Reinforcement Bars (Sub-Committee V).

Specifications for Billet-Steel Concrete Reinforcement Bars.—The proposed revisions in these specifications, indicated in Appendix II, are recommended to provide for an "intermediate" grade of billet-steel reinforcement bar, between the "structural-steel" and "hard" grades.

Steel Forgings and Billets (Sub-Committee VI).

The committee recommends that the following matters be referred to letter ballot of the Society: (1) That the present Standard Specifications for Steel Forgings (adopted 1905), for Heat-Treated Carbon-Steel Axles, Shafts and Similar Objects (revised 1912), and for Steel Forgings for Locomotives (revised 1913), be cancelled and superseded by the proposed Revised Standard Specifications for Carbon-Steel and Alloy-Steel Forgings, for Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars,[1] and for Carbon-Steel Forgings for Locomotives,[1] respectively, as appended to this report;[2] and (2) that the present Standard Specifications for Carbon-Steel Car and Tender Axles, and for Cold-Rolled Steel Axles, be revised as indicated in Appendix II.

Factor Table and Curve for Elongation and Reduction of Area.—In Appendix III will be found a table and curve giving values of the percentages of elongation and reduction of area based on the inverse ratio of the tensile strength—that is, factor ÷ tensile strength—for values of tensile strength from 50,000 to 100,000 lb. per sq. in. and values of the factor from 1,000,000 to 5,000,000. The ductility requirements in the proposed revised specifications for forgings have all been expressed in this way.

It is recommended that Appendix III be printed in the Year-Book and in the form of a separate pamphlet.

Proof Tests of Finished Forgings.—Appendix IV contains the report of a sub-sub-committee on proof tests of finished forgings, appointed in connection with the requirement for proof tests in the proposed Revised Specifications for Quenched-and-Tempered Forgings. This report is submitted for the informa-

[1] In presenting these specifications at the annual meeting, the committee recommended certain amendments, which are given on p. 17.—Ed.

[2] See 1914 Year-Book, pp. 93–110.—Ed.

tion and use of those interested. It is hoped that the committee will be able next year to make definite recommendations as to proof tests to be incorporated in the specifications.

Elastic Limit.—The committee desires to call attention to the fact that the term "elastic limit" as determined by extensometer, instead of "yield point," has been used for quenched-and-tempered and alloy steels pending the report of Committee E-1 on Standard Methods of Testing to be presented at this Annual Meeting.[1]

The committee wishes to emphasize the fact that the proposed revisions in the present Standard Specifications for Steel Forgings (adopted 1905) have been so drastic that it has been thought best to present the proposed Revised Specifications for Carbon-Steel and Alloy-Steel Forgings for adoption to supersede the present ones, rather than a detailed list of the revisions. Since these revised specifications have been used as a basis for the proposed Revised Specifications for Quenched-and-Tempered Forgings and for Carbon-Steel Forgings for Locomotives, the latter have also been presented in the same way. The proposed revisions in the present Standard Specifications for Carbon-Steel Car and Tender Axles and for Cold-Rolled Steel Axles are so few in number that they have been listed in Appendix II rather than append the specifications in their proposed revised form.

As a matter of general information, however, the more important proposed revisions in the three present specifications referred to above will now be given. In all of these specifications the standard sections now embodied in the various specifications for steel have been used wherever possible.

Proposed Revised Specifications for Carbon-Steel and Alloy-Steel Forgings.—Following are the more important revisions recommended in the present Standard Specifications for Steel Forgings, pages 90–93 in the 1913 Year-Book:

1. The title and classes have been changed.

2. *Manufacture.*—Requirements as to discard and boring have been added, as well as a description of the heat treatment specified.

3. *Chemical Properties and Tests.*—The phosphorus and

[1] The Report of Committee E-1 (see pp. 391–396) was referred back to the committee for further consideration.—ED.

sulfur requirements have been changed, and manganese requirements added.

4. *Physical Properties and Tests.*—The classification by sizes has been changed; the ductility requirements are now based on the inverse ratio of the tensile strength, that is, factor ÷ tensile strength; bend tests have been omitted; and the requirements as to number of tests have been changed.

Proposed Revised Specifications for Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars.—Following are the more important revisions recommended in the present Standard Specifications for Heat-Treated Carbon-Steel Axles, Shafts and Similar Objects, pages 97–101 in the 1913 Year-Book:

1. The title has been changed.

2. *Manufacture.*—The description of the heat treatment has been changed, as well as the section on prolongations for tests; the section on warping has been omitted; and requirements as to boring have been added.

3. *Chemical Properties and Tests.*—The manganese requirements have been changed; and maximum and minimum limits for carbon have been given.

4. *Physical Properties and Tests.*—Classification by sizes has been added; the ductility requirements are now based on the inverse ratio of the tensile strength, that is, factor ÷ tensile strength; the method of determining the "elastic limit" has been changed (see the reference to "elastic limit" above); a section providing for proof tests of finished forgings has been added (in this connection see the reference above to Appendix IV); the requirements as to number of tests have been changed; and requirements as to character of fracture and permissible re-quenching have been added to the section on retests.

Attention is directed to the following: (1) That many sections in these specifications are the same as the corresponding ones in the proposed Revised Specifications for Carbon-Steel and Alloy-Steel Forgings; (2) that the tensile properties are the same as those of the corresponding class in the last-named specifications; and (3) that certain requirements have been included that are not covered in the last-named specifications.

Proposed Revised Specifications for Carbon-Steel Forgings for Locomotives.—Following are the more important revisions

recommended in the present Standard Specifications for Steel Forgings for Locomotives, pages 198–201 in the 1913 Year-Book:

1. The title and the section on basis of purchase have been changed.

2. *Manufacture.*—Requirements as to discard and prolongations for tests have been added; and the description of the heat treatment has been changed.

3. *Chemical Properties and Tests.*—Maximum and minimum limits for manganese have been specified.

4. *Physical Properties and Tests.*—Classification by sizes has been added; the ductility requirements are now based on the inverse ratio of the tensile strength, that is, factor ÷ tensile strength; the bend test has been omitted; the requirements as to number of tests have been changed; and requirements as to character of fracture and re-annealing have been added to the section on retests.

As in the case of the proposed Revised Specifications for Quenched-and-Tempered Forgings, many sections in the proposed Revised Specifications for Carbon-Steel Forgings for Locomotives are the same as in the corresponding sections in the proposed Revised Specifications for Carbon-Steel and Alloy-Steel Forgings, and the tensile properties are the same as those of the corresponding classes in the last-named specifications.

Specifications for Carbon-Steel Car and Tender Axles.—The committee recommends that these specifications be revised as indicated in Appendix II. It is the purpose of the committee to cooperate during the ensuing year with the Master Car Builders' Association in the further revision of these specifications with reference to drop-test requirements.

Specifications for Cold-Rolled Steel Axles.—The revisions indicated in Appendix II are minor ones, intended to make these specifications consistent as far as possible with the other specifications in the charge of Sub-Committee VI.

Alloy-Steel Forgings.—Sub-Committee VI has under consideration the preparation of specifications for chrome-nickel, chrome-vanadium and other alloy-steel forgings, with the view of writing them into the Specifications for Carbon-Steel and Alloy-Steel Forgings.

The sub-committee has also been charged with the drafting of specifications for steel chain for cars, and heat-treated knuckle pivot pins.

Steel Castings (Sub-Committee VIII).

Sulfur for Castings for Railway Rolling Stock.—At the last annual meeting, Committee A-1 was instructed to report upon the question of "the allowance of 10 per cent excess on check analysis for sulfur for castings for railway rolling stock."[1] The present Section 23 of the Standard Specifications for Steel Castings specifies 0.05 per cent of sulfur on check analysis, no excess being allowed. The committee has considered this question, and recommends that no change be made in the present requirement. The question will be under consideration during the ensuing year, with a view to making recommendations at the next annual meeting in the light of experience gained in working under the present requirement.

Steel Tubing and Pipe (Sub-Committee IX).

Sub-Committee IX has under consideration the questions of (1) Specifications for Steam Pipes and (2) the Standardization of Pipe Threads. In connection with the latter a number of tests have been made, and the sub-committee has been authorized to cooperate with various associations interested in this question. The committee expects to make definite recommendations in these matters next year.

Automobile Steels (Sub-Committee X).

The committee announces its purpose of revising the present Standard Specifications for Automobile Carbon and Alloy Steels during the coming year to make the requirements for forgings agree in general with those recommended for adoption in this report. In addition, the Iron and Steel Committee of the Society of Automobile Engineers has under consideration certain changes in their specifications for automobile steels, and Sub-Committee X will cooperate with that committee with the view of harmonizing the requirements of the specifications of the two societies so far as may be possible.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).

METHODS OF CHEMICAL ANALYSIS (SUB-COMMITTEE XII).

Proposed New Methods of Chemical Analysis for Plain Carbon Steel.—As stated in its report last year, Committee A-1 has been engaged in the formulation of methods of chemical analysis for steel. Last June Sub-Committee XII on Methods of Chemical Analysis absorbed the work of a sub-committee on this subject of Committee E-1 on Standard Methods of Testing, the records of that sub-committee becoming a part of the records of Sub-Committee XII.

The investigations of Sub-Committee XII have been directed primarily to the accumulation of information which would lead to a selection of methods for the determination of carbon, manganese, phosphorus, silicon and sulfur, impurities common to plain carbon steel, and for copper, nickel and chromium in plain carbon steel occurring as accidental impurities.

It was early recognized that the rapidity of the work and its usefulness, as reflected in the application of the methods suggested for standardization, would be largely dependent upon the cooperation of all interests vitally concerned in such work, and as an evidence of the cooperation of the membership of the Society at large, and the interest manifested in the work, the committee desires to state that 92 laboratories, comprising 51 iron and steel companies, 26 railroad companies, and 15 testing and inspection laboratories, have submitted very careful detail statements covering the methods used by them in the examination of carbon steel.

With this information as a basis, and making free use of all available sources of information dealing with steel analysis in recognized references on the subject, and of governmental and other publications, the sub-committee has drawn up, and Committee A-1 now presents and recommends for adoption, the proposed Standard Methods of Chemical Analysis for Plain Carbon Steel, containing methods for the determination of carbon, manganese, phosphorus, sulfur, silicon, copper, nickel and chromium, appended to this report.[1]

In making this recommendation the committee desires to call attention to the following:

In the case of carbon, manganese, phosphorus, sulfur, and

[1] See 1914 Year-Book, pp. 169–192.—ED.

nickel, two methods are outlined, one to be applied for work requiring the highest refinement, the other for routine work. For silicon two methods are given, both being capable of giving results of highest accuracy and therefore of equal merit from this standpoint. The sulfuric-acid method is given, due to its very general application in the laboratories of steel makers. For copper and chromium two procedures are shown, one to be followed for slight traces, the other where the contents are larger.

In the selection of methods, first consideration has been given to the degree of refinement capable in their application, it being recognized that methods for application in cases of conflicting results—that is, standard methods—should represent the highest degree of refinement in the light of existing information. Next in importance the element of time involved in the determination has been carefully considered, and lastly the element of cost incident to the application of the method.

The method suggested for the determination of carbon by direct combustion of the steel in oxygen and absorption of the carbon dioxide in a solution of barium hydroxide, has been applied for a number of years; and with the development of the special filtering apparatus specified, it is considered to offer many advantages over other suggested schemes, to be capable of giving a degree of refinement not obtainable with other methods, and to be readily adaptable to ordinary laboratory work so soon as familiarity with the filtering apparatus is obtained.

In the bismuthate method for manganese prominence is given to a note stating that the preliminary treatment with sodium bismuthate is apparently unnecessary in the development of results of highest accuracy. Considerable study has been given this point by Sub-Committee XII; however, the data available at this time are not, in the judgment of the sub-committee, sufficiently overwhelming to warrant the omission of the preliminary treatment from the procedure. It is hoped that the members will direct attention to this point, since the omission of the preliminary treatment, if warranted, will reduce the elements of time and cost very materially.

For phosphorus and sulfur the gravimetric methods are suggested for results of highest refinements. It should be stated, however, that the widely used alkalimetric method for phos-

phorus, and the evolution-titration method for sulfur, are capable of highly satisfactory refinement when skilfully applied.

With reference to the suggested methods for copper, nickel and chromium, prominence should be given to the statement that the outlines here presented are intended for application where these elements occur as "accidental" impurities, and not for alloy steels.

The committee desires to record its thanks to Dr. S. W. Stratton of the Bureau of Standards, for the very material assistance rendered by Dr. Hillebrand and the Editorial Committee of the Bureau, in the construction of the various methods as to form and manner of expression.

Methods of Chemical Analysis for Alloy Steels.—Sub-Committee XII has under consideration the preparation of methods for the chemical analysis of alloy steels.

Test Ingots for Ladle Analysis.—The standardization of the methods of obtaining drillings for ladle analysis has been under investigation by Sub-Committee XII during the past year. The sub-committee has collected some interesting information showing the various types and sizes of test ingots used by about fifty steel manufacturers, the position and the number per melt of various sizes, the position and size of the drill hole, and the general procedure in taking drillings for analysis. The investigation will be continued during the coming year, with the cooperation of certain steel companies and the Bureau of Standards.

METHODS OF PHYSICAL TESTS (SUB-COMMITTEE XIII).

Position of Fracture of 2 and 8-in. Tension Test Specimens.—During the past year Committee A-1 has had under consideration the revision of the present requirement for retesting 2-in. tension test specimens which break outside the gage length, and now recommends that the following sections (numbered 1, 2 and 3 for convenience) be adopted by the Society and inserted in the specifications affected, as indicated below.

1. *To apply to 2-in. specimens:*

If the percentage of elongation of any tension test specimen is less than that specified in Section —— and any part of the fracture is more than $\frac{3}{4}$ in. from the center of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

2. *To apply to 8-in. specimens:*

If the percentage of elongation of any tension test specimen is less than that specified in Section —— and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

3. *To apply to 2 and 8-in. specimens:*

If the percentage of elongation of any tension test specimen is less than that specified in Section —— and any part of the fracture is more than $\frac{3}{4}$ in. from the center of the gage length of a 2-in. specimen or is outside the middle third of the gage length of an 8-in. specimen, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

Section No. 1 is to be inserted in the following specifications:

Medium-Carbon-Steel Splice Bars.
High-Carbon-Steel Splice Bars.
Extra-High-Carbon-Steel Splice Bars.
[1] Carbon-Steel and Alloy-Steel Forgings.
[1] Quenched-and-Tempered Carbon-Steel Axles, etc.
[1] Carbon-Steel Forgings for Locomotives.
Cold-Rolled Steel Axles.
Steel Tires.
Steel Castings.

Section No. 2 is to be inserted in the following specifications:

Low-Carbon-Steel Splice Bars.
[1] Structural Steel for Cars.
[2] Structural Steel for Locomotives.
Structural Steel for Ships.
Rivet Steel for Ships.
Billet-Steel Concrete Reinforcement Bars.
Rail-Steel Concrete Reinforcement Bars.
Boiler and Firebox Steel.
Boiler Rivet Steel.

Section No. 3 is to be inserted in the following specifications:

Structural Steel for Bridges.
Structural Nickel Steel.
Structural Steel for Buildings.
Automobile Steels.

The adoption of these sections will carry with it the omission of the italicized words in the present section in all specifications affected, as follows:

"If any test specimen shows defective machining or develops flaws, *or if an 8-in. tension test specimen breaks outside the middle third of the gage length, or if a 2-in. tension test specimen breaks outside the gage length,* it may be discarded ....."

[1] The proposed section has been inserted in these specifications, which are being recommended for adoption this year, subject to adoption by the Society.

[2] Proposed new title of present Standard Specifications for Steel Shapes, Universal Mill Plates and Bars for Locomotive Materials (see Appendix II).

Relation between Yield Point and Tensile Strength.—At the last annual meeting, Committee A-1 was instructed to report upon "the relation between the yield point and the ultimate strength in all of the standard specifications for steel."[1] This question was referred to Sub-Committee XIII. Tests to determine (1) the ratio of yield point to tensile strength and (2) the effect on that ratio of the speed of the testing machine, for structural and forging steels at gage lengths of 2 and 8 in., are being made by the Baldwin Locomotive Works and the Standard Steel Works Co. The cooperation of the Bureau of Standards and the Pennsylvania Railroad Co. in the program of tests for the ensuing year has been secured, and the committee hopes to be able to present final recommendations at the next annual meeting.

Standardization of Methods of Physical Tests.—Sub-Committee XIII has been charged with the standardization of the methods of physical tests prescribed in all of the standard specifications for steel. This work will be done in cooperation with Committee E-1 on Standard Methods of Testing.

MISCELLANEOUS RECOMMENDATIONS AND ANNOUNCEMENTS.

Permissible Variations in Weight and Gage of Sheared Plates.—In recommending in its report last year that the present Specifications for Structural Steel for Ships be adopted by the Society, Committee A-1 stated that the revision of the table of permissible variations in the weight and gage of sheared plates would be considered during the year and reported upon at this meeting.[2] At the request of Committee A-1, The Association of American Steel Manufacturers has submitted a report on this question (see Appendix V), containing the table of permissible variations recently adopted by that association, and recommending its adoption by this Society in all relevant specifications.

Owing to lack of time, this report, with the table of variations, was not before the committee at its last meeting when this question was considered. In view of this the following motion was passed: That the question as to whether the table of permissible variations proposed by The Association of

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 23 (1913).
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, pp. 63-64 (1913).

American Steel Manufacturers shall be substituted for the one in the present specifications of the Society, be referred to letter ballot of the committee together with a copy of the report of the association, with the understanding that if there are more than 10 dissenting votes the ballot shall be counted as lost; and further, that the report shall be appended to the report of Committee A-1 to the Society. This matter has been duly referred to letter ballot of the committee, with the following result: affirmative, 50; negative, 14; not voting, 44.

The ballot is therefore to be counted as lost. The committee recommends that Appendix V be printed in the Proceedings for information, and announces its purpose to reconsider this question during the coming year.

Specifications for Locomotive Materials.—The committee recommends that the following specifications in its charge shall be classed as applicable to locomotives, and so indexed in the Table of Contents of the Year-Book of the Society:

TITLE.	PAGE IN 1913 YEAR-BOOK.
Blooms, Billets and Slabs for Carbon-Steel Forgings	87
Boiler and Firebox Steel	141
Boiler Rivet Steel	146
Carbon-Steel Car and Tender Axles	94[a]
Carbon-Steel Forgings for Locomotives	...[b]
Carbon-Steel Wheels for Engine-Truck, Tender and Passenger Service	106
Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends, and Arch Tubes	202
Quenched-and-Tempered Carbon-Steel Axles, Shafts and other Forgings for Locomotives and Cars	...[c]
Steel Castings, Class B	127
Steel Shapes, Universal Mill Plates, and Bars	206[a]
Steel Tires	122

[a] Recommended revisions are contained in Appendix II.
[b] See 1914 Year-Book, pages 106–110.—ED.
[c] See 1914 Year-Book, pages 100–105.—ED.

The committee further recommends that the title "Standard Specifications for Locomotive Materials," now appearing over certain of the above specifications, be omitted hereafter, in view of the proposed method of indexing recommended above.

These recommendations are based upon the reports of a special sub-committee representing the locomotive builders and the railroads on the committee. This sub-committee, with the consent of Committees A-2 and A-3, also made similar recommendations concerning specifications for wrought iron and for cast iron. The recommendations have been transmitted to these two committees for their action and report at this Annual Meeting.

Miscellaneous.—The committee recommends that when one specification, or certain parts of it, are referred to in a second specification, and thereby made a part of it, the first specification, or the parts designated, shall be reprinted with the second specification under the same cover, in order that the latter specification may be complete.

The committee announces its purpose to consider the following questions during the ensuing year, in addition to those which have previously been mentioned: (1) The drafting of general specifications for rivets, with a review of the sulfur requirements for rivet steel: (2) the question of whether the requirements as to chemical composition shall be expressed as "rejection limits" or as ladle analysis requirements with an allowable excess on check analysis by the purchaser; and (3) certain questions of form affecting the sections on "Inspection and Rejection."

This report has been submitted to letter ballot of the committee, which consists of 108 members, of whom 68 have voted affirmatively, 3 negatively, and 37 have refrained from voting.

Respectfully submitted on behalf of the committee,

C. D. YOUNG,
Chairman.

C. L. WARWICK,
Secretary.

[NOTES.—In presenting the above report at the annual meeting, Committee A-1 recommended certain amendments, which are given on pages 17–18, in the Specifications, for Carbon-Steel Bars for Springs, the Specifications for Quenched-

and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars, and the Specifications for Carbon-Steel Forgings for Locomotives. For action taken on the report as amended, see pages 16 19.

The proposed revisions recommended in sixteen of the standard specifications for steel (see pages 83–84), as amended at the annual meeting, the two proposed new standard specifications and the proposed new standard method (see page 84), and the recommendations relative to the position of fracture of 2 and 8-in. tension test specimens (see pages 98–99), were adopted by letter ballot of the Society on September 10, 1914. The specifications as thus revised and adopted appear in the 1914 Year-Book.

For Discussion on this report, see pages 131–143.—Ed.]

APPENDIX I.

REGULATIONS GOVERNING COMMITTEE A-1.

ARTICLE I.

SECTION 1. These Regulations are supplementary to the "Regulations Governing Technical Committees."

ARTICLE II.

ADVISORY MEMBERS.

SECTION 1. Advisory Members are experts whose advice and cooperation are desired, but who can not or do not wish to become Members of the Committee. They shall be appointed by the Chairman of the Committee upon the request of the chairman of any sub-committee.

SEC. 2. Advisory Members need not be members of the Society. Their names shall not appear in the list of members of Technical Committees printed in the Year-Book of the Society, but shall be kept on the rolls of the Secretary of the Committee and the chairmen of the sub-committees on which they hold membership. They shall be entitled to a vote on such sub-committees, but shall not be entitled to a vote on the Committee.

SEC. 3. Acknowledgment of the assistance rendered by Advisory Members shall be made in the annual report of the Committee.

ARTICLE III.

OFFICERS AND THEIR ELECTION.

SECTION 1. The executive direction of Committee A-1 shall be vested in an Advisory Committee, which shall consist of the Secretary of the Society, *ex officio*, the officers of the Committee, the chairmen of the sub-committees, and any member of the Committee not otherwise eligible serving on at least five sub-committees.

SEC. 2. The officers of Committee A-1 shall be a Chairman, two Vice-Chairmen, and a Secretary.

SEC. 3. (*a*) Any member of the Committee shall be eligible for office; except that the Chairman shall be elected from the representatives of non-producing interests, as provided in the "Regulations Governing Technical Committees."

(*b*) One Vice-Chairman shall be elected from the representatives of non-producing interests, and the other Vice-Chairman from the representatives of producing interests.

SEC. 4. The term of office shall be two years; and officers shall be eligible for re-election.

SEC. 5. The officers shall be elected at a meeting of the Committee held at the time of the Annual Meeting of the Society in the even-numbered years.

SEC. 6. (*a*) A Committee on Nomination of Officers, composed of the chairmen of all existing sub-committees and under the chairmanship of one of its members to be designated by the Chairman of Committee A-1, shall organize immediately following the April meeting of Committee A-1 in the even-numbered years, and shall nominate to Committee A-1, at the time of the meeting for election, one member for Chairman, two members for Vice-Chairmen, and one member for Secretary. Any member of the Committee on Nominations shall be eligible for office.

(*b*) Other nominations may be made on the floor of the meeting.

ARTICLE IV.

MEETINGS.

SECTION 1. *Committee Meetings.*—Regular meetings of Committee A-1 shall be held in Philadelphia, on the first Friday of October, the second Friday of January, the first Friday of April, and at the Annual Meeting of the Society prior to the presentation of the annual report of the Committee.

SEC. 2. *Sub-Committee Meetings.*—(*a*) Regular meetings of sub-committees shall be held immediately preceding the dates of the regular meetings of the Committee. Special meetings of sub-committees may be held in the first week of any month on two weeks' notice from the chairman of the sub-committee.

(*b*) When the chairman of a sub-committee desires to call a meeting of his sub-committee, he shall so notify the Secretary, stating the probable time required for the meeting and his preference as to date and hour. The Secretary shall prepare a schedule of sub-committee meetings with a view of avoiding conflicts, and this schedule shall be printed in the circular letter announcing the meeting of the Committee.

ARTICLE V.

ATTENDANCE AT MEETINGS.

SECTION 1. *Committee Meetings.*—The Secretary of the Committee shall keep a roll of the members of the Committee and shall record at each meeting of the Committee the members in attendance. If a member, or his authorized representative, is absent from two consecutive meetings, without notice to the Secretary assigning reasons for the same, the Secretary shall notify the member that unless he advises that he wishes to continue as a member of the Committee, with assurance that he will in the future be in position to take an active interest in the work of the Committee and attend its meetings, his name will be dropped from the roll of membership. Such notices shall be sent out by the Secretary only on the approval of the Chairman of the Committee.

SEC. 2. *Sub-Committee Meetings.*—The chairman of each sub-committee shall keep a roll of the members of the sub-committee, and shall record at each meeting of the sub-committee the members in attendance. If a member, or his authorized representative, is absent from two consecutive meetings of the sub-committee without notice to the chairman of the sub-committee assigning reasons for the same, the chairman shall notify the Secretary of the Committee. The Secretary shall then notify the member that unless he advises that he wishes to continue as a member of the sub-committee, with assurance that he will in future be in position to take an active interest in the work of the sub-committee and attend its meetings, his name will be dropped from the roll of membership of the sub-committee. Such notices shall be sent out by the Secretary only on the approval of the Chairman of the Committee.

ARTICLE VI.

SUB-COMMITTEES.

SECTION 1. The chairman of a sub-committee shall have authority to appoint, at his discretion, a vice-chairman, a secretary and sub-committees of the sub-committee, and to plan and direct the work of the sub-committee.

SEC. 2. (*a*) All specifications for any given product shall be drafted by the sub-committee in charge of specifications for that product.

(*b*) Any sub-committee considering the drafting of specifications for a general class of material (*e. g.*, steel for bridges, ships, etc.) involving a special class of material (*e. g.*, castings), specifications for which are in the charge of another sub-committee, shall consult with that sub-committee with the object of having the specifications for that special class of material expanded if they are not sufficiently general to cover the proposed new requirements.

(*c*) Sub-committees in charge of specifications for given products shall cooperate, whenever necessary, with other sub-committees, with the object of having the specifications for given products such that they may be included in any other specification involving such products, either by full quotation, or merely by reference to the specifications covering such products individually.

SEC. 3. The Sub-Committee on Literary Form shall submit all proposed changes in the form of specifications, or such other changes as it may desire to recommend, to the proper sub-committee for their consideration before presentation to the Committee.

SEC. 4. The chairman of each sub-committee shall submit to the Committee at each regular meeting a report of the progress of the work assigned to that sub-committee. Such report shall be made by the chairman in person, and a copy filed with the Secretary; except when the chairman is absent from a meeting, in which case the report of the sub-committee shall be made by some member of the sub-committee designated by the chairman of the sub-committee in writing to the Secretary, which member shall be in position to explain all items contained

in the said report. Record of failure to submit such reports shall be entered in the minutes of each meeting.

SEC. 5. If a sub-committee fails to present a report through its chairman, or as otherwise provided in Section 4, at two consecutive meetings of the Committee, the Secretary shall notify the chairman and the members of the sub-committee that they shall show cause to the Advisory Committee why the sub-committee should not be reorganized or discharged. Such notices shall be sent out by the Secretary only on the approval of the Chairman of the Committee.

SEC. 6. The chairman of any sub-committee, or some officer of the same, after the completion of a subject referred to the sub-committee, shall transmit all correspondence filed on that subject to the Secretary of the Committee.

APPENDIX II.

PROPOSED REVISIONS IN PRESENT STANDARD SPECIFICATIONS FOR STEEL AND STEEL PRODUCTS.

In this appendix are given in detail the revisions recommended in eleven of the present standard specifications for steel and steel products. In addition, the committee has recommended that a general revision in the requirements concerning the position of fracture of tension test specimens be made affecting certain specifications.[1]

After the title of each specification is given its page number in the 1913 Year-Book, where the specification appears in its present standard form. The section numbers in italics refer to the specifications as there printed; the proposed new section numbers, where they differ from the present numbers, are given in brackets. If the change in a section is one of numbering only, it has not been noted.

Low-Carbon-Steel Splice Bars (page 36).

1. *Section 9* [proposed Section 9 (*a*)].—Insert at the end the following clause: ", except as specified in Paragraph (*b*)."

2. Insert the following new Section 9 (*b*):

"(*b*) For splice bars for girder and high tee rails, any variation from a straight line in a vertical plane shall be such as will make the bars high in the center, and the maximum camber in this plane shall not exceed $\frac{3}{64}$ in. in 24 in. Any variation from a straight line in a horizontal plane shall be such as will make the bars convex toward the web of the rail, and the maximum camber in this plane shall not exceed $\frac{1}{16}$ in. in 24 in."

[1] See pp. 98–99.—Ed.

MEDIUM-CARBON-STEEL SPLICE BARS (page 39).

1. *Section 6.*—Change to read:

"6. The splice bars shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in..... 68 000

Elongation in 2 in., per cent..... $\frac{1\,600\,000}{\text{Tens. str.}}$,

but in no case under 20 per cent."

2. Strike out Section 7 on "Permissible Variations in Tensile Strength," and renumber the sections following.

3. *Section 12* [proposed Section 11 (*a*)].—Change the third sentence to read:

"A variation of $\frac{1}{32}$ in. from the specified size of holes, of $\frac{1}{16}$ in. from the specified location of holes, and of $\frac{1}{8}$ in. from the specified length of splice bar, will be permitted."

Insert at the end the following clause: "except as specified in Paragraph (*b*)."

4. Insert a new Section 11 (*b*), same as item No. 2, Low-Carbon-Steel Splice Bars.

HIGH-CARBON-STEEL SPLICE BARS (page 43).

1. *Section 11* [proposed Section 11 (*a*)].—Same change as in item No. 3, Medium-Carbon-Steel Splice Bars.

2. Insert a new Section 11 (*b*), same as item No. 2, Low-Carbon-Steel Splice Bars.

EXTRA-HIGH-CARBON-STEEL SPLICE BARS (page 47).

1. *Section 11* [proposed Section 11 (*a*)].—Same change as in item No. 3, Medium-Carbon-Steel Splice Bars.

2. Insert a new Section 11 (*b*), same as item No. 2, Low-Carbon-Steel Splice Bars.

STRUCTURAL STEEL FOR BRIDGES (page 51).

1. *Section 1.*—Change to read:

"1. The Standard Specifications for Steel Castings adopted by the American Society for Testing Materials shall govern the purchase of steel castings for bridges. Unless otherwise specified, Class B castings, medium grade, shall be used."

Omit the footnote to Section 1.

2. *Section 3.*—Change the sulfur requirement for rivet steel from 0.04 to 0.045 per cent.

3. *Section 6* (*a*).—Change the requirement for tensile strength of rivet steel from 48,000–58,000 to 46,000–56,000 lb. per sq. in.

Insert a footnote to the figures for the tensile strength of structural steel referring to the new Section 6 (*b*).

4. Insert the following new Section 6 (*b*), changing present Section 6 (*b*) to 6 (*c*):

"(*b*) In order to meet the required minimum tensile strength of full-size annealed eye bars, the purchaser may determine and specify the tensile strength to be obtained in specimen tests, but the maximum shall not exceed 74,000 lb. per sq. in. The material shall conform to the requirements as to physical properties, other than that of tensile strength, specified in Sections 6, 7 and 8 (*b*)."

5. *Section 7* (*a*).—Insert at the end the following clause: ", to a minimum of 18 per cent."

6. *Section 8* (*a*).—Insert after "bars", line 1, the following clause: " , except as specified in Paragraphs (*b*), (*c*) and (*d*), ".

7. Insert the following new Section 8 (*b*):

"(*b*) The test specimen for eye-bar flats shall bend cold through 180 deg. without cracking on the outside of the

bent portion, as follows: For material $\frac{3}{4}$ in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; for material over $\frac{3}{4}$ in. to and including $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen; and for material over $1\frac{1}{4}$ in. in thickness, around a pin the diameter of which is equal to three times the thickness of the specimen."

8. *Section 8 (b)* [proposed Section 8 (*c*)].—Change "pins and rollers", line 1, to read "pins, rollers and other bars, when prepared as specified in Section 9 (*e*),".

9. Strike out Section 9 on "Tests of Angles," and renumber the sections following.

10. *Sections 10 (a) and (b)* [proposed Sections 9 (*a*) and (*b*)].—Change to read:

"9. (*a*) Tension and bend test specimens shall be taken from rolled steel in the condition in which it comes from the rolls, except as specified in Paragraph (*b*).

"(*b*) Tension and bend test specimens for pins and rollers shall be taken from the finished bars, after annealing when annealing is specified."

11. *Section 10 (c)* [proposed Section 9 (*c*)].—Change "Paragraph (*d*)", line 2, to read "Paragraphs (*d*), (*e*) and (*f*)."

12. *Section 10 (d)* [proposed Section 9 (*d*)].—Change to read:

"(*d*) Tension and bend test specimens for plates, and tension test specimens for eye-bar flats, over $1\frac{1}{2}$ in. in thickness may be machined to a thickness or diameter of at least $\frac{3}{4}$ in. for a length of at least 9 in."

13. *Section 10 (e)* [proposed Section 9 (*e*)].—Change to read:

"(*e*) Tension test specimens for pins, rollers and bars (except eye-bar flats) over $1\frac{1}{2}$ in. in thickness or diameter may be of the form and dimensions shown in Fig. 2. Bend

test specimens may be 1 by $\frac{1}{2}$ in. in section. The axis of the specimen shall be located at any point midway between the center and surface and shall be parallel to the axis of the bar."

STRUCTURAL NICKEL STEEL (page 57).

1. *Section 3.*—Change the sulfur requirement for structural steel from 0.04 to 0.05 per cent, and for rivet steel from 0.04 to 0.045 per cent.

2. Strike out Section 10 on "Tests of Angles," and renumber the sections following.

3. *Section 12* (*a*) [proposed Section 11 (*a*)].—Strike out "rolled or forged", line 2.

STRUCTURAL STEEL FOR BUILDINGS (page 64).

1. *Section 5* (*a*).—Change the requirement for tensile strength of rivet steel from 48,000–58,000 to 46,000–56,000 lb. per sq. in.

2. *Section 6* (*a*).—Insert at the end the following clause: ", to a minimum of 18 per cent."

3. *Section 7* (*a*).—After "bars", line 1, insert ", except as specified in Paragraphs (*b*) and (*c*),".

4. *Section 7* (*b*).—Change "pins and rollers," line 1, to read "pins, rollers and other bars, when prepared as specified in Section 8 (*e*),".

5. *Section 8* (*a*) *and* (*b*).—Change to read:

"8. (*a*) Tension and bend test specimens shall be taken from rolled steel in the condition in which it comes from the rolls, except as specified in Paragraph (*b*).

"(*b*) Tension and bend test specimens for pins and rollers shall be taken from the finished bars, after annealing when annealing is specified."

6. *Section 8 (c).*—Change "Paragraph (*d*)", line 2, to read "Paragraphs (*d*), (*e*) and (*f*)."

7. *Section 8 (d).*—Strike out "and bars", line 1.

8. *Section 8 (e).*—Change to read:

"(*e*) Tension test specimens for pins, rollers and bars over $1\frac{1}{2}$ in. in thickness or diameter may be of the form and dimensions shown in Fig. 2. Bend test specimens may be 1 by $\frac{1}{2}$ in. in section. The axis of the specimen shall be located at any point midway between the center and surface and shall be parallel to the axis of the bar."

LOCOMOTIVE MATERIALS—SHAPES, UNIVERSAL MILL PLATES AND BARS (page 206).

1. Change the title to read as follows, omitting the subtitle "Steel Shapes, Universal Mill Plates and Bars:"

"Standard Specifications for Structural Steel for Locomotives."

2. Insert the following new Section 1, with the marginal heading "Basis of Purchase," and renumber the sections following:

"1. These specifications apply to shapes, plates (except boiler and firebox plates) and bars over $\frac{1}{8}$ in. in thickness."

3. *Section 6 (a)* [proposed Section 7 (*a*)].—Change "20 per cent", last line, to "18 per cent."

4. *Section 6 (b)* [proposed Section 7 (*b*)].—Change to read:

"(*b*) For material under $\frac{5}{16}$ in. in thickness, a deduction of 2.5 from the percentage of elongation in 8 in. specified in Section 6 (*a*) shall be made for each decrease of $\frac{1}{16}$ in. thickness below $\frac{5}{16}$ in."

5. *Section 7* [proposed Section 8].—Strike out "$1\frac{1}{2}$ times", line 5.

6. Strike out Section 8 on "Tests of Angles."

7. *Section 11.*—Strike out and replace by the standard section on "Permissible Variations in Weight and Gage" for structural steel, which appears in the Proposed Standard Specifications for Structural Steel for Cars, Section 11 (see pages 75–79).

8. *Section 14* (*a*) [proposed Section 14].—Strike out " and except as specified in Section 14 (*b*)," lines 9 and 10.

9. Strike out Section 14 (*b*).

10. *Section 15* (*b*).—Strike out "or after inspection in accordance with Section 14 (*b*)," lines 2 and 3.

BILLET-STEEL CONCRETE REINFORCEMENT BARS (page 80).

1. *Section 1* (*b*).—Change to read:

"(*b*) Plain and deformed bars are of three grades, namely: structural-steel, intermediate, and hard."

2. *Section 2* (*a*).—Change to read:

"(*a*) The structural-steel grade shall be used unless otherwise specified."

3. *Section 8* (*a*).—Add the following requirements as to tensile properties for a new intermediate grade:

	PLAIN BARS.	DEFORMED BARS.
Tensile strength, lb. per sq. in.	70 000 – 85 000	70 000 – 85 000
Yield point, min., lb. per sq. in.	40 000	40 000
Elongation in 8 in., min., per cent.	$\frac{1\,300\,000}{\text{Tens. str.}}$	$\frac{1\,125\,000}{\text{Tens. str.}}$

4. *Section 10.*—Add the following bend-test requirements for a new intermediate grade:

	PLAIN BARS.	DEFORMED BARS.
Under $\frac{3}{4}$ in.	180 deg. d = 2t	180 deg. d = 3t
$\frac{3}{4}$ in. or over	90 deg. d = 2t	90 deg. d = 3t

CARBON-STEEL CAR AND TENDER AXLES (page 94).

1. *Section 5 (c).*—Change to read:

"The temperature of the test axle shall be between 40 and 120° F."

2. *Section 7.*—Add the following sentence:

"Not less than 30 axles shall be offered from any one melt, unless otherwise agreed upon by the manufacturer and the purchaser."

3. *Section 10.*—Change to read:

"Identification marks shall be legibly stamped on each axle. The purchaser shall indicate the location of such identification marks."

4. *Section 11.*—Change to read:

"11. (*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the axles ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the axles are being furnished in accordance with these specifications. Tests and inspection at the place of manufacture shall be made prior to shipment.

"(*b*) The purchaser may make the chemical tests to govern the acceptance or rejection of the axles in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

"(*c*) All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works."

5. *Section 12.*—Change "Section 4", line 2, to "Section 11 (*b*)."

6. *Section 13.*—Change "Section 4", line 1, to "Section 11 (*b*)."

COLD-ROLLED STEEL AXLES (page 102).

1. *Section 5.*—Change the last sentence to read:

"Drillings for analysis may be taken from the axle or from a full-size prolongation of the same, at any point midway between the center and surface; or turnings may be taken from a test specimen."

2. *Section 12.*—Change the last sentence to read:

"The purchaser shall indicate the location of such identification marks."

APPENDIX III.

VALUES OF PERCENTAGES OF ELONGATION AND REDUCTION OF AREA BASED ON INVERSE RATIO OF THE TENSILE STRENGTH.

Submitted by Sub-Committee VI, on Steel Forgings and Billets, of Committee A-1.

In Table I (Plate I) and Fig. 1 are shown values of percentages of elongation and reduction of area based on inverse ratio of the tensile strength, that is, factor ÷ tensile strength. Values in the table have been computed for tensile strengths varying by increments of 1000 lb. per sq. in. from 50,000 to 100,000 lb. per sq. in., inclusive, and for values of the factor varying by increments of 100,000 from 1,000,000 to 5,000,000. The curves have been plotted for values of the factor from 1,000,000 to 6,000,000.

Table I.—Values of Percentages of Elongation and Reduct

For Values o

Tensile Strength, lb. per sq. in.	1 000 000	1 100 000	1 200 000	1 300 000	1 400 000	1 500 000	1 600 000	1 700 000	1 800 000	1 900 000	2 000 000	2 100 000	2 200 000	2 300 000	2 400 000	2 500 000	2 600 000	2 700 000
50 000	20.0	22.0	24.0	26.0	28.0	30.0	32.0	34.0	36.0	38.0	40.0	42.0	44.0	46.0	48.0	50.0	52.0	54
1 000	19.6	21.6	23.5	25.5	27.5	29.4	31.4	33.3	35.3	37.3	39.2	41.2	43.1	45.1	47.1	49.0	51.0	52
2 000	19.2	21.2	23.1	25.0	26.9	28.8	30.8	32.7	34.6	36.5	38.5	40.4	42.3	44.2	46.2	48.1	50.0	51
3 000	18.9	20.8	22.6	24.5	26.4	28.3	30.2	32.1	34.0	35.8	37.7	39.6	41.5	43.4	45.3	47.2	49.1	50
4 000	18.5	20.4	22.2	24.1	25.9	27.8	29.6	31.5	33.3	35.2	37.0	38.9	40.7	42.6	44.4	46.3	48.1	50
5 000	18.2	20.0	21.8	23.6	25.5	27.3	29.1	30.9	32.7	34.5	36.4	38.2	40.0	41.8	43.6	45.5	47.3	49
6 000	17.9	19.6	21.4	23.2	25.0	26.8	28.6	30.4	32.1	33.9	35.7	37.5	39.3	41.1	42.9	44.6	46.4	48
7 000	17.5	19.3	21.1	22.8	24.6	26.3	28.1	29.8	31.6	33.3	35.1	36.8	38.6	40.4	42.1	43.9	45.6	47
8 000	17.2	19.0	20.7	22.4	24.1	25.9	27.6	29.3	31.0	32.8	34.5	36.2	37.9	39.7	41.4	43.1	44.8	46
9 000	16.9	18.6	20.3	22.0	23.7	25.4	27.1	28.8	30.5	32.2	33.9	35.6	37.3	39.0	40.7	42.4	44.1	45
60 000	16.6	18.3	20.0	21.6	23.3	25.0	26.6	28.3	30.0	31.6	33.3	34.9	36.6	38.3	39.9	41.6	43.3	44
1 000	16.4	18.0	19.7	21.3	22.9	24.6	26.2	27.9	29.5	31.1	32.8	34.4	36.1	37.7	39.3	41.0	42.6	44
2 000	16.1	17.7	19.4	21.0	22.6	24.2	25.8	27.4	29.0	30.6	32.3	33.9	35.5	37.1	38.7	40.3	41.9	43
3 000	15.9	17.5	19.0	20.6	22.2	23.8	25.4	27.0	28.6	30.2	31.7	33.3	34.9	36.5	38.1	39.7	41.3	42
4 000	15.6	17.2	18.7	20.3	21.9	23.4	25.0	26.6	28.1	29.7	31.2	32.8	34.4	35.9	37.5	39.1	40.5	42
5 000	15.4	16.9	18.5	20.0	21.5	23.1	24.6	26.2	27.7	29.2	30.8	32.3	33.8	35.4	36.9	38.5	40.0	41
6 000	15.2	16.7	18.2	19.7	21.2	22.7	24.2	25.8	27.3	28.8	30.3	31.8	33.3	34.9	36.4	37.9	39.4	40
7 000	14.9	16.4	17.9	19.4	20.9	22.4	23.9	25.4	26.9	28.4	29.9	31.3	32.8	34.3	35.8	37.3	38.8	40
8 000	14.7	16.2	17.6	19.1	20.6	22.1	23.5	25.0	26.5	27.9	29.4	30.9	32.4	33.8	35.3	36.8	38.2	39
9 000	14.5	15.9	17.4	18.8	20.3	21.7	23.2	24.6	26.1	27.5	29.0	30.4	31.9	33.3	34.8	36.2	37.7	39
70 000	14.3	15.7	17.1	18.6	20.0	21.4	22.9	24.3	25.7	27.1	28.6	30.0	31.4	32.9	34.3	35.7	37.1	38
1 000	14.1	15.5	16.9	18.3	19.7	21.1	22.5	23.9	25.4	26.8	28.2	29.6	31.0	32.4	33.8	35.2	36.6	38
2 000	13.9	15.3	16.7	18.1	19.4	20.8	22.2	23.6	25.0	26.4	27.8	29.2	30.6	31.9	33.3	34.7	36.1	37
3 000	13.7	15.1	16.4	17.8	19.2	20.5	21.9	23.3	24.7	26.0	27.4	28.8	30.1	31.5	32.9	34.2	35.6	37
4 000	13.5	14.9	16.2	17.6	18.9	20.3	21.6	23.0	24.3	25.7	27.0	28.4	29.7	31.1	32.4	33.8	35.1	36
5 000	13.3	14.7	16.0	17.3	18.7	20.0	21.3	22.7	24.0	25.3	26.7	28.0	29.3	30.7	32.0	33.3	34.7	36
6 000	13.2	14.5	15.8	17.1	18.4	19.7	21.1	22.4	23.7	25.0	26.3	27.6	28.9	30.3	31.6	32.9	34.2	35
7 000	13.0	14.3	15.6	16.9	18.2	19.5	20.8	22.1	23.4	24.7	26.0	27.3	28.6	29.9	31.2	32.5	33.8	35
8 000	12.8	14.1	15.4	16.7	17.9	19.2	20.5	21.8	23.1	24.4	25.6	26.9	28.2	29.5	30.8	32.1	33.3	34
000	12.7	13.9	15.2	16.5	17.7	19.0	20.3	21.5	22.8	24.1	25.3	26.6	27.8	29.1	30.4	31.6	32.9	34
80 000	12.5	13.8	15.0	16.3	17.5	18.8	20.0	21.3	22.5	23.8	25.0	26.3	27.5	28.8	30.0	31.3	32.5	33
1 000	12.3	13.6	14.8	16.0	17.3	18.5	19.8	21.0	22.2	23.5	24.7	25.9	27.2	28.4	29.6	30.9	32.1	33
2 000	12.2	13.4	14.6	15.9	17.1	18.3	19.5	20.7	22.0	23.2	24.4	25.6	26.8	28.0	29.3	30.5	31.7	32
3 000	12.0	13.3	14.5	15.7	16.9	18.1	19.3	20.5	21.7	22.9	24.1	25.3	26.5	27.7	28.9	30.1	31.3	32
4 000	11.9	13.1	14.3	15.5	16.6	17.9	19.0	20.2	21.4	22.6	23.8	25.0	26.2	27.4	28.6	29.8	31.0	32
5 000	11.8	12.9	14.1	15.3	16.5	17.6	18.8	20.0	21.2	22.4	23.5	24.7	25.9	27.1	28.2	29.4	30.6	31
6 000	11.6	12.8	14.0	15.1	16.3	17.4	18.6	19.8	20.9	22.1	23.3	24.4	25.6	26.7	27.9	29.1	30.2	31
7 000	11.5	12.6	13.8	14.9	16.1	17.2	18.4	19.6	20.7	21.8	23.0	24.1	25.3	26.4	27.6	28.7	29.9	31
8 000	11.4	12.5	13.6	14.8	15.9	17.0	18.2	19.3	20.5	21.6	22.7	23.9	25.0	26.1	27.3	28.4	29.5	30
9 000	11.2	12.4	13.5	14.6	15.7	16.9	18.0	19.1	20.2	21.3	22.5	23.6	24.7	25.8	27.0	28.1	29.2	30
90 000	11.1	12.2	13.3	14.4	15.6	16.7	17.8	18.9	20.0	21.1	22.2	23.3	24.4	25.6	26.7	27.8	28.9	30
1 000	11.0	12.1	13.2	14.3	14.4	16.5	17.6	18.7	19.8	20.9	22.0	23.1	24.2	25.3	26.4	27.5	28.6	29
2 000	10.9	12.0	13.0	14.1	15.2	16.3	17.4	18.5	19.6	20.7	21.7	22.8	23.9	25.0	26.1	27.2	28.3	29
3 000	10.8	11.8	12.9	14.0	15.1	16.1	17.2	18.3	19.4	20.4	21.5	22.6	23.7	24.7	25.8	26.9	28.0	29
4 000	10.6	11.7	12.8	13.8	14.8	16.0	17.0	18.1	19.2	20.2	21.3	22.3	23.4	24.5	25.5	26.6	27.7	28
5 000	10.5	11.6	12.6	13.7	14.7	15.8	16.8	17.9	18.9	20.0	21.1	22.1	23.2	24.2	25.3	26.3	27.4	28
6 000	10.4	11.5	12.5	13.5	14.6	15.6	16.7	17.7	18.8	19.8	20.8	21.9	22.9	24.0	25.0	26.0	27.1	28
7 000	10.3	11.3	12.4	13.4	14.4	15.5	16.5	17.5	18.6	19.6	20.6	21.7	22.7	23.7	24.7	25.8	26.8	27
8 000	10.2	11.2	12.2	13.3	14.3	15.3	16.3	17.3	18.4	19.4	20.4	21.4	22.4	23.5	24.5	25.5	26.5	27
9 000	10.1	11.1	12.1	13.1	14.1	15.2	16.2	17.2	18.2	19.2	20.2	21.2	22.2	23.2	24.2	25.3	26.3	27
100 000	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0	21.0	22.0	23.0	24.0	25.0	26.0	27

OF TENSILE STRENGTH = FACTOR ÷ TENSILE STRENGTH.

IVE.

3 600 000	3 700 000	3 800 000	3 900 000	4 000 000	4 100 000	4 200 000	4 300 000	4 400 000	4 500 000	4 600 000	4 700 000	4 800 000	4 900 000	5 000 000	Tensile Strength, lb. per sq. in.
72.0	74.0	76.0	78.0	80.0	82.0	84.0	86.0	88.0	90.0	92.0	94.0	96.0	98.0	100.0	50 000
70.6	72.5	74.5	76.5	78.4	80.4	82.4	84.3	86.3	88.2	90.2	92.2	94.1	96.1	98.0	1 000
69.2	71.2	73.1	75.0	76.9	78.8	80.8	82.7	84.6	86.5	88.5	90.4	92.3	94.2	96.2	2 000
67.9	69.8	71.7	73.6	75.5	77.4	79.2	81.1	83.0	84.9	86.8	88.7	90.6	92.5	94.3	3 000
66.7	68.5	70.4	72.2	74.1	75.9	77.8	79.6	81.5	83.3	85.2	87.0	88.9	90.7	92.6	4 000
65.5	67.3	69.1	70.9	72.7	74.5	76.4	78.2	80.0	81.8	83.6	85.5	87.3	89.1	90.9	5 000
64.3	66.1	67.9	69.6	71.4	73.2	75.0	76.8	78.6	80.4	82.1	83.9	85.7	87.5	89.3	6 000
63.2	64.9	66.7	68.4	70.2	71.9	73.7	75.4	77.2	78.9	80.7	82.5	84.2	86.0	87.7	7 000
62.1	63.8	65.5	67.2	69.0	70.7	72.4	74.1	75.9	77.6	79.3	81.0	82.8	84.5	86.2	8 000
61.0	62.7	64.4	66.1	67.8	69.5	71.2	72.9	74.6	76.3	78.0	79.7	81.4	83.1	84.7	9 000
60.0	61.7	63.3	65.0	66.7	68.3	70.0	71.7	73.3	75.0	76.7	78.3	80.0	81.7	83.3	60 000
59.0	60.7	62.3	63.9	65.6	67.2	68.9	70.5	72.1	73.8	75.4	77.1	78.7	80.3	82.0	1 000
58.1	59.7	61.3	62.9	64.5	66.1	67.7	69.4	71.0	72.6	74.2	75.8	77.4	79.0	80.6	2 000
57.1	58.7	60.3	61.9	63.5	65.1	66.7	68.3	69.8	71.4	73.0	74.6	76.2	77.8	79.4	3 000
56.2	57.8	59.4	60.9	62.5	64.1	65.6	67.2	68.8	70.3	71.9	73.4	75.0	76.6	78.1	4 000
55.4	56.9	58.5	60.0	61.5	63.1	64.6	66.2	67.7	69.2	70.8	72.3	73.8	75.4	76.9	5 000
54.6	56.1	57.6	59.1	60.6	62.1	63.6	65.2	66.7	68.2	69.7	71.2	72.7	74.3	75.8	6 000
53.7	55.2	56.7	58.2	59.7	61.2	62.7	64.2	65.7	67.2	68.7	70.2	71.6	73.1	74.6	7 000
52.9	54.4	55.9	57.4	58.8	60.3	61.8	63.2	64.7	66.2	67.7	69.1	70.6	72.1	73.5	8 000
52.2	53.6	55.1	56.5	58.0	59.4	60.9	62.3	63.8	65.2	66.7	68.1	69.6	71.0	72.5	9 000
51.4	52.9	54.3	55.7	57.1	58.6	60.0	61.4	62.9	64.3	65.7	67.1	68.6	70.0	71.4	70 000
50.7	52.1	53.5	54.9	56.3	57.8	59.2	60.6	62.0	63.4	64.8	66.2	67.6	69.0	70.4	1 000
50.0	51.4	52.8	54.2	55.6	56.9	58.3	59.7	61.1	62.5	63.9	65.3	66.7	68.1	69.4	2 000
49.3	50.7	52.1	53.4	54.8	56.2	57.5	58.9	60.3	61.6	63.0	64.4	65.8	67.1	68.5	3 000
48.6	50.0	51.4	52.7	54.1	55.4	56.8	58.1	59.5	60.8	62.2	63.5	64.9	66.2	67.6	4 000
48.0	49.3	50.7	52.0	53.3	54.7	56.0	57.3	58.7	60.0	61.3	62.7	64.0	65.3	66.7	5 000
47.4	48.7	50.0	51.3	52.6	53.9	55.3	56.6	57.9	59.2	60.5	61.8	63.2	64.5	65.8	6 000
46.8	48.1	49.4	50.7	51.9	53.2	54.5	55.8	57.1	58.4	59.7	61.0	62.3	63.6	64.9	7 000
46.2	47.4	48.7	50.0	51.3	52.6	53.8	55.1	56.4	57.7	59.0	60.3	61.5	62.8	64.1	8 000
45.6	46.8	48.1	49.4	50.6	51.9	53.2	54.4	55.7	57.0	58.2	59.5	60.8	62.0	63.3	9 000
45.0	46.3	47.5	48.8	50.0	51.3	52.5	53.8	55.0	56.3	57.5	58.8	60.0	61.3	62.5	80 000
44.4	45.7	46.9	48.2	49.4	50.6	51.9	53.1	54.3	55.6	56.8	58.0	59.3	60.5	61.7	1 000
43.9	45.1	46.3	47.6	48.8	50.0	51.2	52.4	53.7	54.9	56.1	57.3	58.5	59.8	61.0	2 000
43.4	44.6	45.8	47.0	48.2	49.4	50.6	51.8	53.0	54.2	55.4	56.6	57.8	59.0	60.2	3 000
42.9	44.1	45.2	46.4	47.6	48.8	50.0	51.2	52.4	53.6	54.8	56.0	57.1	58.3	59.5	4 000
42.4	43.5	44.7	45.9	47.1	48.2	49.4	50.6	51.8	52.9	54.1	55.3	56.5	57.7	58.8	5 000
41.9	43.0	44.2	45.4	46.5	47.7	48.8	50.0	51.2	52.3	53.5	54.7	55.8	57.0	58.1	6 000
41.4	42.5	43.7	44.8	46.0	47.1	48.3	49.4	50.6	51.7	52.9	54.0	55.2	56.3	57.5	7 000
40.9	42.0	43.2	44.3	45.5	46.6	47.7	48.9	50.0	51.1	52.3	53.4	54.5	55.7	56.8	8 000
40.5	41.6	42.7	43.8	44.9	46.1	47.2	48.3	49.4	50.6	51.7	52.8	53.9	55.1	56.2	9 000
40.0	41.1	42.2	43.3	44.4	45.6	46.7	47.8	48.9	50.0	51.1	52.2	53.3	54.5	55.6	90 000
39.6	40.7	41.8	42.9	44.0	45.1	46.2	47.3	48.4	49.5	50.6	51.7	52.8	53.9	54.9	1 000
39.1	40.2	41.3	42.4	43.5	44.6	45.7	46.7	47.8	48.9	50.0	51.1	52.2	53.3	54.3	2 000
38.7	39.8	40.9	41.9	43.0	44.1	45.2	46.2	47.3	48.4	49.5	50.5	51.6	52.7	53.8	3 000
38.3	39.4	40.4	41.5	42.6	43.6	44.7	45.7	46.8	47.9	48.9	50.0	51.1	52.1	53.2	4 000
37.9	38.9	40.0	41.1	42.1	43.2	44.2	45.3	46.3	47.4	48.4	49.5	50.5	51.6	52.6	5 000
37.5	38.5	39.6	40.6	41.7	42.7	43.8	44.8	45.8	46.9	47.9	49.0	50.0	51.0	52.1	6 000
37.1	38.1	39.2	40.2	41.2	42.3	43.3	44.3	45.4	46.4	47.4	48.5	49.5	50.5	51.5	7 000
36.7	37.8	38.8	39.8	40.8	41.8	42.9	43.9	44.9	45.9	46.9	48.0	49.0	50.0	51.0	8 000
36.4	37.4	38.4	39.4	40.4	41.4	42.4	43.4	44.4	45.5	46.5	47.5	48.5	49.5	50.5	9 000
36.0	37.0	38.0	39.0	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	100 000

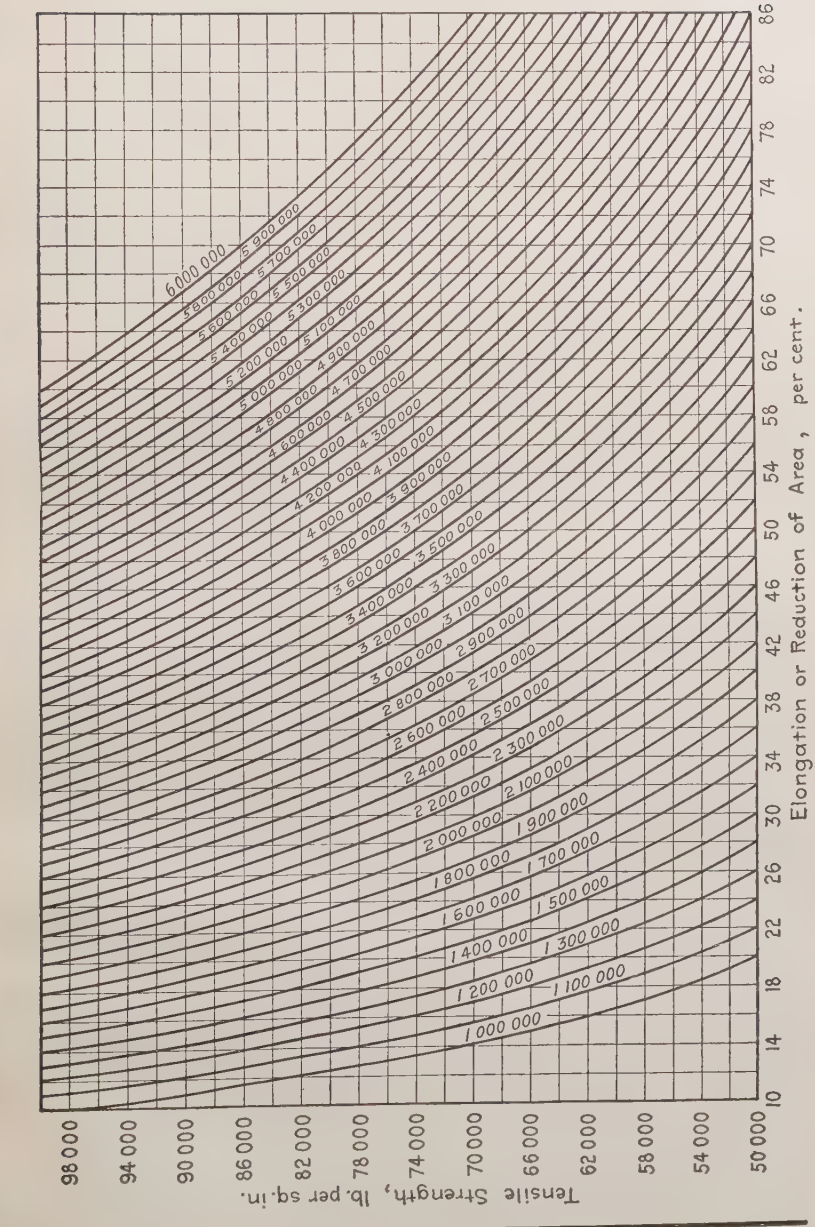


FIG. 1.—Values of Percentages of Elongation and Reduction of Area Based on Factor ÷ Tensile Strength.

APPENDIX IV.

REPORT ON PROOF TESTS OF FINISHED FORGINGS

CONDUCTED UNDER THE DIRECTION OF SUB-COMMITTEE VI, ON STEEL FORGINGS AND BILLETS, OF COMMITTEE A-1.

PITTSBURGH, March 6, 1914.

MR. A. A. STEVENSON, *Chairman*,
Sub-Committee VI, Committee A-1, A. S. T. M.,

Dear Sir:

Under date of February 8, 1914, you appointed the following as a Sub-Sub-Committee:

Hugh P. Tiemann, Metallurgist, Carnegie Steel Co., Chairman;
J. A. Capp, Chief of Testing Laboratory, General Electric Co.;
E. F. Kenney, Metallurgical Engineer, Cambria Steel Co.;
F. M. Waring, Foreman, Physical Laboratory, Pennsylvania Railroad Co.;
H. V. Wille, Assistant to Superintendent, Baldwin Locomotive Works.

At your invitation the following were appointed to serve:

A. R. Ayers, General Mechanical Engineer, Lake Shore & Michigan Southern Railway Co., representing the American Railway Master Mechanics' Association;
J. P. Barnes, General Manager, Syracuse & Suburban Railroad Co., representing the American Electric Railway Engineering Association.

The subject to be considered was "Proof Tests to Determine Soundness of Finished Forgings."

Meetings were held February 26 in Pittsburgh, and March 6 in Philadelphia, at the latter of which a table and chart prepared by Mr. L. H. Fry were presented and accepted by the committee (see Table I and Fig. 1). These show the comparison of proof drop tests required by the Pennsylvania Railroad Co., Standard Steel Works Co., and New York Central Lines, for axles or other forgings of nearly uniform cross-section and of sizes up to 12 in. in diameter and up to 8 ft. in length.

The Pennsylvania Railroad Co. and the Standard Steel Works Co. apply a proof test to axles only and require the test to be made on an M.C.B. standard axle drop-testing machine with spring-supported anvil and supports 3 ft. apart. The New York Central Lines apply a proof test to axles, rods, and similar forgings, with supports placed at the ends of the forgings to be tested. The supports rest on a solid anvil without springs. As a consequence the New York Central proof test can hardly be compared with the other two, as the use of a so-called "solid support" for the anvil makes the effect of any drop test extremely uncertain. The effect will vary between different drop-testing machines according to the nature of the ground and of the foundation supporting the anvil, and in the same drop-testing machine the effect of the same height of blow will be much more severe with frozen ground than when the ground is soft.

It will be seen from Fig. 1 that the proof tests required by the Pennsylvania Railroad Co. and by the Standard Steel Works Co. are almost identical, though so far as we can learn they were developed independently. The test of the Standard Steel Works Co., which was established by Mr. H. V. Wille of the Baldwin Locomotive Works, is the outcome of a number of experiments in which a determination of the blow required to produce permanent set was made for axles of several different sizes. The proof test was then set at a somewhat lighter blow. The figures of the Pennsylvania Railroad Co. are based on a theory developed some years ago for drop-testing car axles with the modifications necessary to change from a destructive to a proof test.

The fact that the two methods of testing, though developed

independently, are almost identical, and that both have been in use for some time with satisfactory results, appears to give them strong claims for confidence.

COMPARISON OF PROOF TESTS FOR QUENCHED-AND-TEMPERED FORGINGS.

Explanation of Figure and Table.—Fig. 1 has been drawn to give a graphic method of comparing the three methods of proof tests of which the requirements are given in Table I.

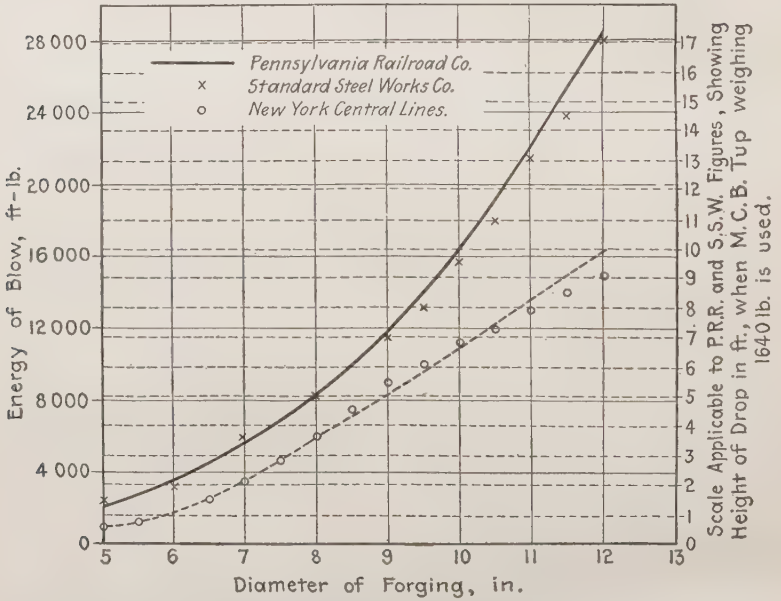


FIG. 1.—Curves showing Comparison of Proof Tests for Quenched-and-Tempered Forgings.

NOTES.—The requirements of the Pennsylvania Railroad Co. are shown by the full line; they are derived from the formula $H = d^3/100$, where H = height of drop in feet and d = diameter of axle in inches.

The requirements of the Standard Steel Works Co. are shown by the points marked (x).

(Both of the foregoing are based on the use of the M.C.B. drop-testing machine with top weighing 1640 lb.)

The requirements of New York Central Lines are shown by the points marked (o). The dotted line is a curve drawn to give a fair average for these points.

Table I is based on the requirements of the three methods to be compared. The New York Central Lines specify for the diameters given in column No. 1, that one blow shall be given, the energy of the blow to be as shown in column No. 2. The Standard Steel Works Co. specify for the sizes of axles opposite which figures appear in column No. 6, that two blows shall be

TABLE I.—COMPARISON OF PROOF TESTS FOR QUENCHED-AND-TEMPERED FORGINGS.

Diameter, in.	Energy of Blow, ft. lb.			Height of Drop for M. C. B. Standard Tup Weighing 1640 lb., ft.	
	New York Central.	Pennsylvania Railroad.	Standard Steel Works.	Pennsylvania Railroad.	Standard Steel Works.
1	2	3	4	5	6
5	900	2 050	2 460	1.25	1.5
5½	1 200	2 720	.....	1.66	....
6	1 700	3 540	3 280	2.16	2.0
6½	2 500	4 510	.....	2.75	....
7	3 500	5 620	5 750	3.43	3.5
7½	4 700	6 940	.....	4.23	....
8	6 000	8 400	8 200	5.12	5.0
8½	7 500	10 050	.....	6.14	....
9	9 000	11 800	11 480	7.29	7.0
9½	10 000	14 100	13 120	8.60	8.0
10	11 000	16 400	15 680	10.0	9.5
10½	12 000	19 100	18 040	11.6	11.0
11	13 000	22 200	21 400	13.4	13.0
11½	14 000	25 000	23 800	15.2	14.5
12	15 000	28 400	28 000	17.3	17.0

given on an M.C.B. drop-testing machine, the tup of 1640 lb. falling from the height shown in column No. 6. The Pennsylvania Railroad Co. also specify two blows on an M.C.B. drop-testing machine, the height of the blow in feet (H) being determined for a given diameter in inches (d) by the formula $H = d^3/100$. The heights of drop found from this formula for the various diameters are given in column No. 5.

For the Standard Steel Works Co., the axle is turned on its axis through 180 deg. between the two blows, and at the same time is moved so that for the first blow one wheel-fit and for the second blow the other wheel-fit rests on a support.

In the case of the Pennsylvania Railroad Co., the axle is tested with two blows, being rotated 180 deg. after the first blow. The axle is struck at the center, the ends projecting an equal distance beyond the supports.

From these specified heights of drop in the case of the Pennsylvania Railroad Co. and the Standard Steel Works Co., the energy of the blow in foot pounds has been calculated and is given in columns Nos. 3 and 4 for comparison with the energy specified by the New York Central Lines. In comparing the figures, however, it must be borne in mind that the New York Central tests are made on a solid anvil, the forging being supported at the ends, while for the Pennsylvania Railroad Co. and the Standard Steel Works Co. tests a spring-supported anvil is used with supports for the forging 3 ft. apart. As a consequence of these differences no direct comparison is possible.

It is recommended that this report be published in the Proceedings of the Society in the form of an appendix to the Report of Committee A-1, as a guide for the testing of axles and similar forgings of nearly uniform cross-section and of sizes up to 12 in. maximum diameter and up to 8 ft. in length.

Attention is called to the fact that owing to the miscellaneous character of forgings covered by a general specification, it is impracticable, with present information on the subject, to give tests which will cover all possible cases.

Respectfully submitted,

HUGH P. TIEMANN,
Chairman.

APPENDIX V.

REPORT ON PERMISSIBLE VARIATIONS IN WEIGHT AND GAGE OF SHEARED PLATES.

SUBMITTED BY THE ASSOCIATION OF AMERICAN STEEL MANUFACTURERS AT THE REQUEST OF COMMITTEE A-1.

STEELTON, PA., April 29, 1914.

C. D. YOUNG, *Chairman*,
Committee A-1, A. S. T. M.

Dear Sir:

The first table of permissible variations in sheared plates was adopted by The Association of American Steel Manufacturers August 9, 1895, and at that time covered only two classes of widths—under 75 in. and 75 to 100 in. The thicknesses ran from $\frac{1}{4}$ to $\frac{5}{8}$ in., with one last division for over $\frac{5}{8}$ in. This table, with additions for thinner and wider plates which were made later, has continued in effect up to the present time.

It was the intent and has been the practice of the Association to apply the tables formulated in 1895 and revised from time to time, to averages and not to individual plates.

These tables have often been quoted, for instance as in the various specifications for structural steel of the American Society for Testing Materials, as applying to individual plates, but they have never been generally so applied in actual practice; in fact it would be almost impossible for a mill to operate on certain thicknesses and widths, if the old tables were thus applied. In revising the Manufacturers' Standard Specifica-

tions for Structural and Boiler Steel in 1912 the Association, having in mind the great desirability of harmonizing the requirements with the specifications of the American Society for Testing Materials, changed the wording so as to specify "each plate," to agree with the text which had been adopted shortly before by the other society. With the meager information that was available at that time it was impossible to predict the full effect of applying the percentages to individual plates, and the impracticability of doing so was not realized until the new specifications came into general use.

On October 26, 1912, Chief Constructor Watt of the Bureau of Construction and Repair, U. S. N., acting as chairman of Sub-Committee III of Committee A-1, asked the Association through its secretary:

1. If it would be possible to make a commercial table of variations for plates with reference to the combination of the allowance in weight and undergage at edge; and

2. In case the manufacturers would not be prepared to meet such a table, whether the old table of variations could not be modified to give a finer sub-division of widths?

As a result of a careful canvass of all the plate manufacturers of the Association, it was found impracticable to adopt in any commercial specification a table limiting at once the weight and the gage of plates ordered to weight per square foot.

The Association, however, instructed one of its committees to go over the schedule in view of Chief Constructor Watt's request. This committee has devoted much time and labor during the past year and a half to collecting data from all the plate manufacturers in the United States in order to establish a criterion of good rolling. With this information the tables dated 1914 accompanying this report (see Plate II) were prepared. To facilitate comparison of the old tables with the new, their figures have been re-arranged in similar tabular form. Remembering that the old tables were intended to apply only to averages, while the new tables may be used for individual plates, the general improvement in mill practice will be clearly evident.

These 1914 tables have now been unanimously adopted by The Association of American Steel Manufacturers and it is

Table I.—Variations Apply to Averages.

1896.

Permissible Variations When Ordered to Weight.

Ordered Weight, lb. per sq. ft.	Percentage Variation from Theoretical Weight, For Width of Plate as follows:					
	Under 75 in.		75 to 100 in.		100 in. or over.	
	Over	Under	Over	Under	Over	Under
Under 12.5	2.5	2.5	5	3	10	3
12.5 or over	2.5	2.5	2.5	2.5	5	5

Permissible Variations When Ordered to Gage.

Plates considered up to gage if measuring not over 0.01 in. less than the ordered gage.

Thickness Ordered, in.	Excess in Percentage of Nominal Weight, For Width of Plate as follows:						
	Under 50 in.	50 to 70 in.	70 in. or over	Under 75 in.	75 to 100 in.	100 to 115 in.	115 in. or over
$\frac{1}{8}$ to $\frac{5}{32}$	10	15	20	...	...	...	...
$\frac{5}{32}$ " $\frac{3}{16}$	8.5	12.5	17	...	...	...	...
$\frac{3}{16}$ " $\frac{1}{4}$	7	10	15	...	...	...	...
$\frac{1}{4}$	...	...	...	10	14	18	...
$\frac{5}{16}$	...	...	...	8	12	16	...
$\frac{3}{8}$	...	...	...	7	10	13	17
$\frac{7}{16}$	...	...	...	6	8	10	13
$\frac{1}{2}$	...	...	...	5	7	9	12
$\frac{5}{8}$	...	...	...	4	6	8	10
Over $\frac{5}{8}$	...	...	...	3.5	5	6.5	9

Variations for $\frac{3}{16}$-in. plates were also included. These were half-way

I.—VARIATIONS APPLY TO INDIVIDUAL PLATES.

1914.

VARIATIONS IN WEIGHT AND GAGE OF SHEARED PLATES.

0.2833 lb.

nt of each plate shall not vary from the weight ordered, more than the amount given in the following table:

VARIATIONS IN WEIGHT OF PLATE FOR WIDTH GIVEN, EXPRESSED IN PERCENTAGE OF ORDERED WEIGHT.

60 in. incl. to 72 in. excl.		72 in. incl. to 84 in. excl.		84 in. incl. to 96 in. excl.		96 in. incl. to 108 in. excl.		108 in. incl. to 120 in. excl.		120 in. incl. to 132 in. excl.		132 in. or over.	
Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under	Over	Under
7	4	8	4	...	...	...	...	...	...	...	...	...	...
6.5	4	7.5	4	...	...	...	...	...	...	...	...	...	...
6	4	7	4	8	4	10	4	11	5	...	...	...	...
5.5	4	6	4	7	4	7.5	4	9	4	10	4	12	5
4.5	4	5	4	5.5	4	6	4	7	4	9	4	11	4
4	3	4.5	3	4.5	3.5	5	4	6	4	8	4	10	4
3.5	3	4	3	4.5	3	5	3	6	4	7	4	9	4
3.5	2.5	3.5	3	4	3	4.5	3	5	4	6	4	8	4
2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	4	5	4	7	4
2.5	2.5	2.5	2.5	3	2.5	3.5	2.5	4	3.5	4.5	4	6.5	4
2.5	2.5	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3.5	6	4

shall not vary more than 0.01 in. under that ordered, and the over weight of each plate shall not exceed the amount

CESS IN WEIGHT OF PLATE FOR WIDTH GIVEN, EXPRESSED IN PERCENTAGE OF NOMINAL WEIGHT.

60 in. incl. to 72 in. excl.	72 in. incl. to 84 in. excl.	84 in. incl. to 96 in. excl.	96 in. incl. to 108 in. excl.	108 in. incl. to 120 in. excl.	120 in. incl. to 132 in. excl.	132 in. or over.
17	20	....	....	....	....	...
15	17	....	....	....	....	....
12	14	17	20	23	....	....
10	12	14	17	20	23	26
9	10	12	14	17	20	23
8	9	10	12	14	17	20
7	8	9	10	12	14	17
6	7	8	9	10	12	14
5	6	7	8	9	10	12
4	5	6	7	8	9	10
3.5	4	5	6	7	8	9

desired that they replace the old tables originally prepared by the Association in whatever specifications of the American Society for Testing Materials the latter may occur.

Respectfully submitted in accordance with the request of Committee A-1 at its meeting April 3, 1914, and by order of the Association,

Yours very truly,

P. E. CARHART,
President.

FRANK A. ROBBINS, JR.,
Secretary.

MINORITY REPORT.

As representatives of the American Electric Railway Engineering Association on Committee A-1 on Standard Specifications for Steel and its Sub-Committee VI on Steel Forgings, we wish to protest against the action which the committee has taken in submitting to the Society a proposed revision of the present Standard Specifications for Heat-Treated Axles, Shafts, and Similar Objects, without due consideration being given to the wishes of the American Electric Railway Engineering Association and before it could have the attention of that Association at its annual meeting. The first specification covering this class of material was originated by one of the member companies of the American Electric Railway Engineering Association, and then adopted by that Association, which later, at the solicitation of some of the members of the American Society for Testing Materials, entered into joint consideration with that Society in the production of the present standard specifications of the Society entitled "Specifications for Heat-Treated Axles, Shafts, and Similar Objects." The specifications which Committee A-1 now proposes are general, covering axles, shafts, and other forgings for locomotives and cars, and would consequently supersede the present specifications for heat-treated axles. To this the representatives of our Association strongly objected in the meetings of Sub-Committee VI and Committee A-1, as the requirement of the new specifications, while in some respects an improvement over those of the existing specifications, do not, in the main essentials, retain the high standard set by the original specifications, and particularly with reference to the elongation and reduction of area, required to be not less than 22 and 45 per cent, respectively, for all tensile strength above a minimum of 85,000 lb. per sq. in. It is proposed to place the elongation and reduction of area on a sliding-scale basis, such that with a tensile strength of 85,000 lb., an elongation of 23.5 per cent is permitted as a minimum, with 91,000 lb., 22.0 per cent as a minimum, and with 97,000

lb., a minimum of 20.6 per cent as the ultimate limit is reached; and with a tensile strength of 85,000 lb. a minimum reduction of area of 44.7 per cent is permitted, with a tensile strength of 90,000 lb., a reduction of area of 42.2 per cent is permitted, scaling down to a minimum of 39.2 per cent for a tensile strength of 97,000 lb.; covering forgings of various sizes within the range of standard driving axles for electric railway work.

While it is frankly admitted that in no instance will the minimum reduction requirements of the proposed specifications be as high as those of the present specifications, it is claimed by certain members of Committee A-1 that the above arrangement should actually result in a higher minimum requirement for the elongation than that called for in the present specifications for this class of material. We do not agree with this contention, and base our opinion in this respect on experience which has shown us that even with the incentive to keep the tensile strength low in order to meet the elongation and reduction requirements of the present specifications, in the majority of cases the tensile strength exceeds 91,000 lb. per sq. in. Moreover, in the specifications as proposed, the tendency will be greatly in favor of a high tensile strength, as this will not only permit of a reduced elongation and reduction requirement, but will also result in a lower elastic ratio.

After having submitted argument in favor of retaining practically the present physical properties and made motion to this effect, which was lost by negative vote of all members present at the meeting of Committee A-1 held in Philadelphia on April 3 and 4, 1914, but without any explanation in support of action taken, or submitting any evidence to indicate that there was any reason for not supporting this motion, the representative of our Association endeavored to have the title changed to read "Specifications for Quenched-and-Tempered Carbon-Steel Axles, Shafts, and other Forgings for Locomotives and Trailer Axles for Cars," in this way excluding electric motor driving axles and armature shafts. A motion to this effect was lost, notwithstanding the fact that the argument has been made that if it were defeated you were overruling the wishes of the originators of the specifications, without explanation, in our opinion, justifying your action.

The Executive Members of our Association exceedingly deplore this action, feeling that as the specifications in question had been adopted by this Society after being suggested by our Association, and after cooperative consideration with this Society, it should not be modified by you without direct consultation with the American Electric Railway Engineering Association, which is the engineering representation of the electric railway companies—extensive users of this material, for which these specifications are intended. Our executive members feel that such action cannot help but jeopardize the value of the cooperative work of the two societies.

Respectfully submitted,

AMERICAN ELECTRIC RAILWAY ENGINEERING ASSOCIATION.

NORMAN LITCHFIELD,
Representative.
J. P. BARNES,
W. E. JOHNSON,
Special Representatives.

DISCUSSION ON THE REPORT OF COMMITTEE A-1.

Mr. A. A. Stevenson.

Mr. A. A. Stevenson.—In view of the fact that a minority report has been presented bearing on the proposed Standard Specifications for Quenched-and-Tempered Carbon-Steel Forgings, it seems proper that I, as chairman of Sub-Committee VI on Forgings, should submit the following table showing the results of ballots on these specifications:

	In Favor.	Opposed.	Not Voting.
On final motion passed by Sub-Committee VI to submit these specifications to Committee A-1.....	16	0	2
Committee A-1, on motion to submit these specifications to letter ballot of Committee A-1.....	Unanimous.		
Committee A-1 on letter ballot to submit these specifications to the Society.....	C 37, P 21 — 58	1, 1 — 2	15, 7 — 22

C denotes Consumers; P denotes Producers.

Before presenting the minority report, I should like to call your attention to the fact that Sub-Committee VI has been working in connection with the Committee of the Master Mechanics' Association handling quenched-and-tempered and alloy-steel forgings. Two or three members of the Master Mechanics' Committee are members of Sub-Committee VI. We took up with Mr. Ayers, Chairman of the Master Mechanics' Committee, the question of having an official representative at meetings of Sub-Committee VI. He appointed Mr. H. E. Smith of the Lake Shore & Michigan Southern Railway Co. as his official representative. Mr. Smith attended all the sub-committee meetings, had the privilege of the floor and had a vote. A sub-committee of Sub-Committee VI was also appointed to meet with the Master Mechanics' Committee. There were two meetings of these committees. The result of this cooperative

Mr. Stevenson. action was that two weeks ago at the annual meeting of the Master Mechanics' Association, Mr. Ayers' committee submitted a report covering quenched-and-tempered forgings, which is practically identical with the report we are submitting to you to-day. The report has gone out to the Master Mechanics' Association for vote as "recommended practice."

[The minority report[1] was here read by Mr. Stevenson.]

Before the discussion of this report I should like to call your attention to the statement in this report that "while in some respects an improvement over those specifications already existing, the specifications do not in the main essentials retain the high standing set by the original specifications." It was brought up at a recent meeting of Committee A-1 that there was practically only one essential of the specifications to which the American Electric Railway Engineering Association are very much opposed, that is, the ductility requirement.

Mr. Capp. MR. J. A. CAPP (*Acting Chairman of Committee A-1*).—Mr. W. E. Johnson, the representative of the American Electric Railway Engineering Association, is here, and the committee would like to have him given an opportunity now of making any supplementary statement he may desire in respect to this minority report.

The Chairman. THE CHAIRMAN (MR. ROBERT W. HUNT).—I take it that the minority report should be considered as in the same class as though it were an amendment to a motion to refer the specifications in question to letter ballot. It is the refore properly before you for your consideration and we shall be glad to hear from Mr. Johnson.

Mr. Johnson. MR. W. E. JOHNSON.—In connection with Mr. Capp's suggestion that I make a supplementary statement, I wish only to add that Mr. Stevenson is correct in his statement that our objections are based principally on the reduced elongation and reduction of area proposed, but I also want to call attention to the fact that this reduction in our opinion has considerable bearing upon the proper heat treatment of the material. If the specifications as now proposed are permitted to go into effect, it will not be necessary to give to the heat treatment the care that we believe it should receive, and that is our main objection

[1] See pp. 128–130.—ED.

to the specifications. Mr. Chairman, in view of the fact that these specifications are not satisfactory to the electric railway users and will not be adopted by the American Electric Railway Engineering Association, I should like permission to make a motion that the same action be taken with reference to these specifications as in the case of the specifications for spring steel, namely, to exclude from these specifications such materials as are used entirely by the electric railways, that is, electric railway motor driving axles. Mr. Johnson.

The Chairman.—Is it your wish to include also armature shafts in your motion? The Chairman.

Mr. Johnson.—There is no reference to armature shafts in the specifications, but it is my intention that they should be excluded as well, and that the title for the specifications should read "Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives, and Trailer Axles for Cars," thus excluding electric railway motor driving axles which are used entirely by the electric railway interests. Mr. Johnson.

Mr. Capp.—If I may take Mr. Stevenson's time for just a minute I should like to call attention to the fact that this same motion was first made in Sub-Committee VI, and defeated after a long discussion. In Committee A-1 a motion to exactly the same effect was repeated, and again defeated. In other words, Committee A-1 has given this very matter which Mr. Johnson has brought up before you very long consideration. The question of the proper physical properties for heat-treated forgings was taken up, I think, at at least two, and I really believe at three of the six meetings of Sub-Committee VI. We labored hard and long over the question of the ductility requirements for these quenched-and-tempered forgings, because the same requirements are included in the general forgings specifications. Mr. Johnson was willing to accept them in the general specifications, because specifications were to be provided specifically covering the particular product in which he is interested, namely, axles for electric railway cars. The matter was first discussed in connection with the general specifications, and then sidetracked for more specific discussion when the specifications for electric railway cars were taken up. It was again fought out when considering the detail specifications for shafts and axles Mr. Capp.

Mr. Capp. for locomotives and cars, and the effect of the minority report is that of a report of one against the record of a vote which the chairman of the sub-committee has read to you. In other words, there is a difference between Mr. Johnson and the other representatives of the American Electric Railway Engineering Association on the one hand, and the rest of Committee A-1 on the other. With this explanation, unless Mr. Stevenson wishes to supplement it, we are willing to rest content with the submission of the motion to ballot.

Mr. Onderdonk. MR. J. R. ONDERDONK.—I should like to ask as to what the difference between the present specification and the proposed specification amounts to? In the minority report, it is stated that in the majority of cases the tensile strength exceeds 91,000 lb. per sq. in. If that is true, a great many of the forgings would probably run between 91,000 and 93,000 lb. tensile strength. If that is the case, what would be the difference between the two specifications in percentage of elongation and reduction of area? I think if Mr. Johnson would give us these figures, it would show us just what it is in the present specifications that he claims is an improvement over the proposed one.

The Chairman. THE CHAIRMAN.—Are there any other remarks? There is one point that the Chair should like to have cleared up. So far as my own understanding of the situation is concerned, the minority report speaks officially of a prospective action of the American Electric Railway Engineering Association, while, if I understand Mr. Capp, he rather presents the matter as though Mr. Johnson were speaking in his individual capacity.

Mr. Capp. MR. CAPP.—No sir, Mr. Johnson is the spokesman for the American Electric Railway Engineering Association. The difference of opinion effectively is whether the specifications that they propose are commercially practicable specifications, and the effect of the discussion by Committee A-1 was that they are not commercially practicable specifications.

Mr. Johnson. MR. JOHNSON.—I am very glad that you made that point clear to the house. It is true the objections that we raise refer to material that is used only by the electric railway industry. As to the present specifications being commercially practicable, I can say that we have been buying material under these specifica-

tions for several years and in so far as the elongation and reduction is concerned have found them to be practicable. Mr. Johnson.

Regarding Mr. Onderdonk's statement that probably the tensile strength would run from 91,000 to 93,000 lb., I want to say that in a large number of cases, the tensile strength for this class of material runs up to 97,000 to 98,000 lb., and even over 100,000 lb. per sq. in., which, in accordance with the proposed specifications, would then only require the minimum elongation, or 20.5 per cent, as against the present requirement of 22 per cent.

Mr. Capp.—Mr. Chairman, I cannot, of course, speak officially for Mr. Young, chairman of the committee; but in his discussion of this very point with Mr. Johnson at the committee meeting, Mr. Young brought out the fact that in the electrification of many of their lines, they, that is the Pennsylvania Railroad Co., are using exactly the same material for exactly the same purpose and that he is not in agreement with the official representative of the American Electric Railway Engineering Association of which his company is a member, but that they dissent from that opinion and would adopt the specifications which Committee A-1 here proposes. Mr. Capp.

Mr. Onderdonk.—As I understand it then, there is only a difference of 1.5 per cent, in the elongation when we get up to the higher ultimate strength or only 0.03 in. difference in stretch, between the proposed specification and the present one. If we happen to get lower tensile strength, we have a higher or better specification. Mr. Onderdonk.

Mr. H. B. MacFarland.—It is not a question necessarily of what one gets, but the possibility of what one may get according to the specifications which the American Electric Railway Engineering Association want to adopt. They must accept material with a tensile strength as low as 85,000 lb. and with an elongation of only 22 per cent. Mr. MacFarland.

According to the specifications proposed by Committee A-1 such material would be rejected. Material would also be rejected that gave as high as 91,000 lb. tensile strength with 22 per cent elongation. Above 91,000 lb. there is a region where material would be accepted with less than 22 per cent elongation that would be rejected by the American Electric Railway Engineering Association's specifications.

Mr. MacFarland. If the two areas are shown on a strength-elongation chart, they are found to be about equal, so that the opportunities for rejection are about the same under both specifications. The material acceptable under the specifications of Committee A-1, but not acceptable under the specifications of the American Electric Railway Engineering Association, on account of having less than 22 per cent elongation, has the virtue of having a greater product of tensile strength and elongation than material that might be accepted under the specifications of the American Electric Railway Engineering Association, but would not meet the specifications of Committee A-1; because under the latter it has to have an altogether better ultimate value.

Mr. Thackray. MR. G. E. THACKRAY.—At a recent meeting of Committee A-1, Mr. Johnson, representing the American Electric Railway Engineering Association, made a statement regarding heat treatment and explained that the tensile strength ordinarily would run over 90,000 lb., and Mr. Hunnings stated that he had made a series of tests which entirely corroborated the tests begun 40, 50 or 60 years ago by Wöhler, which indicated that the higher tensile strength gained by the heat treatment had more value as regards the life and breakage of material than did this small percentage of reduction of area. In other words, material of which the tensile strength has been increased by heat treatment will wear longer, last longer and break less, than material with lower tensile strength, notwithstanding the fact that the elongation and reduction of area of the higher tensile material is considerably less than that of the lower tensile material. That has been the experience for many years in the manufacture of axles and heat-treated material, and in my opinion it goes almost without saying that the specifications now proposed by Committee A-1 are those best adapted to give the best material for the purpose intended.

Mr. Johnson. MR. JOHNSON.—Mr. Onderdonk's statement that the elongation proposed would be only 1.5 per cent less than what we would require is true. But I also want to call attention to the fact that the minimum reduction of area would be 6 per cent less than our present requirement, whereas we have found that where the reduction of area is as low as that proposed, microscopical examination of the structure indicates that proper heat

treatment had not been given the material. Regarding Mr. MacFarland's comment, I think the minority report explains that very clearly, and I do not believe that under the proposed specifications there would be very much danger of material being submitted for inspection with a tensile strength of less than 91,000 lb., thus requiring an elongation as high as the present specifications. The tendency would be to increase the tensile strength and thus permit of the lower elongation and reduction. Mr. Johnson.

MR. S. V. HUNNINGS.—Before that question is voted upon, I should like to call attention to some vibratory results included in the paper "A New Vibratory Machine, and Results Obtained by Its Use,"[1] which has been referred to by Mr. Thackray. Specimens 120*C* and 112*B* show approximately the same tensile strength and yield point, but although the former specimen showed 3.5 per cent higher elongation and approximately 17 per cent higher reduction of area than specimen 112*B*, the average vibratory result was only 7.46 per cent higher than that shown by specimen 120*C*; on the other hand, specimen 109*B*, which showed 4 per cent lower elongation and less than 1 per cent higher reduction of area, but approximately 15,000 lb. higher tensile strength and 12,000 lb. higher yield point, than shown by specimen 112*B*, showed 56.35 per cent higher vibratory results than specimen 112*B*. Mr. Hunnings.

From these results it will be seen that even a pronounced difference in the elongation and reduction of area has little bearing on the life of material as compared with the influence of higher tensile strength and higher yield point, in combination with reasonable elongation and reduction of area.

In view of the results quoted, and other tests I have made, which have shown similar results, I am satisfied that Mr. Johnson is needlessly alarmed by the slight change in elongation and reduction of area required by these specifications, and that it will really result to his advantage, in view of the probability of his receiving forgings of a higher tensile strength and yield point, than he has been receiving under the present specifications.

MR. JOHNSON.—Mr. Hunnings' statement bears out our contention exactly. The forging to which he refers as giving the fewest number of vibrations before failure, would not meet the Mr. Johnson.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part II (1914).

Mr. Johnson. present specifications of the American Electric Railway Engineering Association, while the forging which gave the highest result meets our specifications and represents a fair average of the material obtained when purchasing under our present specifications.

[Mr. Johnson's motion, above mentioned, was lost.]

Mr. Stevenson. MR. STEVENSON.—In submitting now the proposed revisions in the present Standard Specifications for Carbon-Steel Car and Tender Axles, it may be of interest to add that a sub-committee of Sub-Committee VI was appointed to confer with the committee on this subject of the Master Car Builders' Association. This sub-committee found that the principal change that was being made by that committee was in the weight of the tup, this change being necessitated by the increased size of axles. The report of that committee did not, however, cover the range of sizes that was deemed necessary for our specifications, and the sub-committee accordingly reported that in view of the lack of information they felt that it would be unwise to recommend any change in the weight of tup at the present time.

Mr. Hunnings. MR. HUNNINGS (*by letter*).—In answer to Mr. Johnson, I would say that the tests I quoted were to prove to him how little influence elongation and reduction of area have upon the dynamic quality of the material as compared with the influence of elastic limit and ultimate strength. A proper basis of comparison, therefore, was that of two specimens of approximately the same strength but widely different elongation and reduction of area, with a specimen of much higher strength but lower elongation and reduction of area. While it is true, as stated by Mr. Johnson, that specimens 120*C* and 112*B* would not have met the requirements of the old specification, it is also true that they do not meet the requirements of the proposed specification. This condition, however, does not affect the value of the tests quoted, as illustrating the point I was arguing, namely, that a difference of a few per cent in elongation and reduction of area has very little influence on the life of material, as compared with the influence of an increase in tensile strength.

In view of Mr. Johnson's stand in this matter, I would

call his attention to the vibratory test of specimens 109*B* and 112*A*. Specimen 109*B*, although several thousand pounds higher in tensile strength, slightly higher in elongation and much higher in reduction of area than specimen 112*A*, showed an average vibratory result several hundred lower than that shown by specimen 112*A*. Mr. Hunnings.

MR. C. D. YOUNG (*Chairman of Committee A-1, by letter*).—For the information of those members of the Society who do not hold membership on Committee A-1, it seems desirable to enter briefly upon the salient features of the minority report of the representatives of the American Electric Railway Engineering Association (to be referred to hereafter as the A. E. R. E. A.), appended to the annual report of Committee A-1, and upon one or two features of the verbal discussion following the presentation of the report at the annual meeting at which the A. E. R. E. A. was represented by Mr. W. E. Johnson, who participated in this discussion. Mr. Young.

It is stated in the minority report that the requirements of the proposed revised Standard Specifications for Heat-Treated Axles, Shafts and other Forgings, "while in some respects an improvement over those of the existing specifications, do not in the main essentials maintain the high standard set by the original specifications, and particularly with reference to the elongation and reduction of area." Before entering upon the discussion of these points somewhat in detail, I desire to state that these particular features of the specifications in question, namely, elongation and reduction of area, were made the subject of prolonged and critical discussion, both at meetings of the sub-committee immediately concerned with these specifications and at meetings of Committee A-1 as a whole, and that the conclusions reached were based, according to the views of the overwhelming majority of the committee, on sound technical grounds.

The minority report also contains the statement that after the representative of the A. E. R. E. A. had "submitted argument in favor of retaining practically the present physical properties and made motion to this effect, which was lost by negative vote of all members present at the meeting of Committee A-1 held in Philadelphia on April 3 and 4, 1914, but without any explana-

Mr. Young. tion in support of action taken, or submitting any evidence to indicate that there was any reason for not supporting this motion," Committee A-1 failed to support the representative of the A. E. R. E. A. in his endeavor to have the title of the specifications so changed as to exclude electric motor driving axles and armature shafts. As a matter of fact, and as previously stated, the points in question were made the subject of prolonged critical discussion at the meetings above referred to and many data bearing on these features of the specifications were presented by various members of the committee in support of the recommendations finally reported. The representative of the A. E. R. E. A. at these meetings failed on the contrary to produce evidence of a technical nature showing that the position taken by the committee was not correct, but contented himself with the reiteration of the statement that their specifications were preferable, and that manufacturers were willing to furnish material according to these specifications. It is pertinent to add further that certain members of Committee A-1 represented large users of heat-treated axles and other forgings, both in connection with steam and electric service. These members were unanimously opposed to excepting from the specifications in question motor driving axles and armature shafts inasmuch as they had been using material of the grade specified with entire satisfaction in connection with both classes of service.

As indicative of the substantial unanimity of sentiment among the members of Committee A-1 with respect to these particular specifications, it may be pointed out that on the letter ballot of the committee the affirmative vote on these specifications was 58, the negative 2, and that 22 members refrained from voting. Of the 58 affirmative votes 37 were cast by consumers and 21 by producers, and of the negative vote of 2, one represents that of the A. E. R. E. A. and the other that of a producer. Of the 22 members who refrained from voting 15 were consumers and 7 producers.

I shall turn now to the more detailed consideration of the particular features that have been singled out for criticism.

Elongation.—Elaborating upon the discussion contributed by Mr. MacFarland, by the specifications proposed by Commit-

tee A-1, the minimum allowable elongation is fixed by the ratio $\frac{2{,}000{,}000}{\text{Tens. Str.}}$ with an absolute minimum of 20.5 per cent corresponding to a tensile strength of 97,000 lb. For the tensile strength a minimum of 85,000 lb. is prescribed, corresponding to a minimum allowable elongation of 23.5 per cent. The maximum allowable range of elongation lies, therefore, between the limits of 20.5 per cent and 23.5 per cent. The A. E. R. E. A. specifications prescribe a minimum elongation of 22 per cent, Mr. Young.

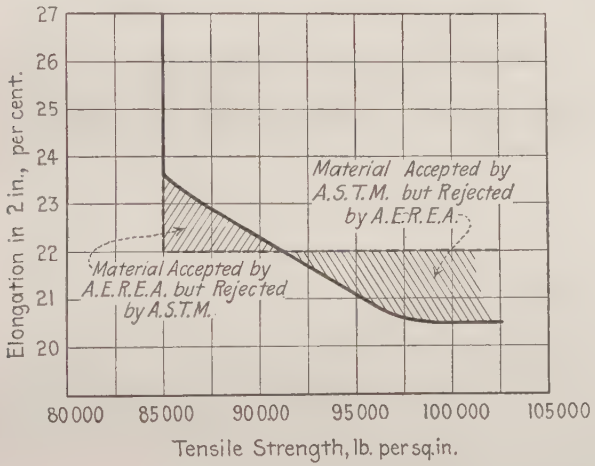


FIG. 1.—Comparison of A. S. T. M. and A. E. R. E. A. Specifications with respect to Elongation.

irrespective of the value of the tensile strength. The comparison between the two specifications as regards elongation is shown graphically in Fig. 1. For a tensile strength of 91,000 lb. both specifications give the same minimum allowable elongation of 22 per cent. For a tensile strength below 91,000 lb. material showing an elongation of only 22 per cent, and acceptable under the A. E. R. E. A. specifications, would be rejected by the A. S. T. M. specifications; and for a tensile strength above 91,000 lb., material showing an elongation below 22 per cent and acceptable under the A. S. T. M. specifications, would be rejected by the A. E. R. E. A. specifications. In accordance with

Mr. Young. a well-known law of the physical properties of steel, the percentage of elongation would normally decrease as the tensile strength increases, and in the judgment of Committee A-1, it is logical that that law should be recognized in these specifications.

Reduction of Area.—The reduction of area in its relation to tensile strength follows the same general law with respect to steel to which attention has just been called. Committee A-1 therefore considers it logical that the reduction of area should be specified as a sliding factor, diminishing with increase

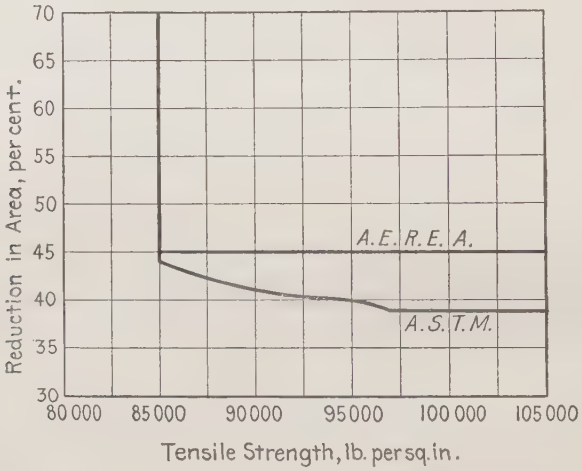


FIG. 2.—Comparison of A. S. T. M. and A. E. R. E. A. Specifications with respect to Reduction of Area.

of tensile strength. The specifications provide for a reduction of area according to the ratio $\frac{3{,}800{,}000}{\text{Tens. Str.}}$, with an absolute minimum of 39 per cent, corresponding to a tensile strength of 97,000 lb. For the minimum allowable tensile strength of 85,000 lb., the minimum allowable reduction of area is, by this ratio, 44.7 per cent. The extreme range of reduction of area by the A. S. T. M. specifications, as graphically shown in Fig. 2, lies, therefore, between the limits of 39 and 44.7 per cent, whereas the A. E. R. E. A. specifications prescribe a constant minimum value of 45 per cent, irrespective of the value of the tensile strength. In

considering the difference in this respect between the require- Mr. Young.
ments of the two specifications, it will be noted that for the minimum tensile strength of 85,000 lb. the specified reductions of area are practically identical, with the incidental advantage to the user of the A. S. T. M. specifications that the required elongation is substantially higher. Evidently a designer must base his calculations in connection with the strength of axles on the minimum tensile strength admissible under the specifications. A lowering of the requirement for reduction of area as the tensile strength increases is offset by such increase in the tensile strength. Majority action in this matter was also largely influenced by the consideration that a reduction-of-area clause is of little value in specifications for quenched-and-tempered material. The determining factors according to which the steel will be tempered (or annealed) are the requirements as to elastic limit and percentage of elongation, the reduction of area obtained following in due course, its value varying consistently with the elastic limit and elongation.

In confirmation of the contention that the reduction-of-area clause in a specification of this kind is unessential, reference may be made to the specifications promulgated by the Engineering Standards Committee of Great Britain, under the auspices of the leading engineering and technical societies. In these specifications no requirement is prescribed for reduction of area.

REPORT OF COMMITTEE A-2

ON

STANDARD SPECIFICATIONS FOR WROUGHT IRON.

The work of Committee A-2 during the past year has included the consideration of the following business:

Sub-Committee I on Tubes and Pipe.—This sub-committee held joint meetings during the past year with Sub-Committee IX on Steel Tubing and Pipe, of Committee A-1, in connection with the consideration of a proposed change in the form of the standard thread for pipe.

Sub-Committee III on Staybolt and Engine Bolt Iron.—When the present Standard Specifications for Staybolt Iron, page 210 in the 1913 Year-Book, were revised in 1912, the committee in its annual report that year called special attention to the fact that the increase of 2 per cent in elongation and 3 per cent in reduction of area recommended at that time was not placing any greater hardship on the manufacturer, owing to the incorporation of Section 7 (*b*), which required a retest where specimens broke outside the middle third of the gage length, or which contained flaws not visible before testing. As experience has since demonstrated that it is impossible or impracticable to observe the provisions of the section in question, when iron is sampled at the place of manufacture but tested at the laboratory of the purchaser, the committee recommends the insertion in the Standard Specifications for Staybolt Iron of the following Section 7 (*c*) covering a permissible variation in elongation and reduction of area, when the retest provision of Section 7 (*b*) is not allowable:

"7. (*c*) When retests as specified in Paragraph (*b*) are not permitted, a reduction of 2 per cent in elongation and 3 per cent in reduction of area from that specified in Section 3 (*a*) shall be allowed."

The vote of the committee on this recommendation is as follows: affirmative, 17; negative, 3; not voting, 9.

During the past year the committee has conducted experiments with a view to establishing a standard vibratory requirement for staybolt iron. Comparative series of tests made on the several types of machines in use finally demonstrated that it would be impossible, on account of their widely different construction, to formulate a standard method of testing that could be strictly adhered to on any two types of machines. As a result of this condition the committee is of the opinion that until such a time as they can see sufficient merit in any particular machine to warrant the adoption of a vibratory requirement based on that or a similar type of machine, the reinsertion of a vibratory requirement in the Standard Specifications for Staybolt Iron will have to be held in abeyance.

Sub-Committee IV on Chain Iron and Iron Chain.—This sub-committee has held several meetings during the year for the purpose of formulating a specification for iron chain, but work was not completed in time to permit action by the Society this year. The sub-committee will continue its work during the ensuing year with a view to offering such a specification for consideration at the next annual meeting.

At the request of Committee A-1 on Standard Specifications for Steel, Committee A-2 received the following recommendation from a special sub-committee of Committee A-1 charged with classifying existing specifications as to their adaptability to locomotive construction:

That Committee A-2 recommend to the Society that the following specifications for wrought iron be classed as applicable to locomotive construction:

Title.	Page in 1913 Year-Book.
Engine Bolt Iron	162
Refined Wrought Iron Bars	165
Staybolt Iron (modified as recommended above)	210
Lap-Welded Iron Boiler Tubes	213

This recommendation has been approved by Committee A-2.

This report has been submitted to letter ballot of the com-

mittee, which consists of 29 members, of whom 24 have voted affirmatively, 2 negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

S. V. HUNNINGS,
Chairman.

J. B. YOUNG,
Secretary.

[NOTE.—The proposed amendment in the Standard Specifications for Staybolt Iron was adopted by letter ballot of the Society on September 10, 1914. The specifications as amended appear on pages 212–214 of the 1914 Year-Book.—ED.]

REPORT OF COMMITTEE A-3

ON

STANDARD SPECIFICATIONS FOR CAST IRON AND FINISHED CASTINGS.

During the last year the attention of the committee has been directed to the revision of two of the standard specifications originally issued, namely, those for locomotive cylinders, and for malleable castings.

The peculiar nature of cast iron and the characteristics of general foundry practice are such that but little progress in the art is possible, castings being made to-day as they were over three hundred years ago. Hence there is scant opportunity for an advance in specifications covering cast iron and finished castings. In fact, unless new methods of treating molten iron from the cupola or furnace are devised, such as the desulfurization in partial measure at least, our standard specifications will eventually have to be lowered somewhat to cover a poorer material.

The requirements of the practice in gray-iron casting make it necessary to use cast-iron scrap in increasing quantity. The constant remelting of this material has gradually raised the sulfur content, so that to-day this is double what it was twenty years ago. In any revised specifications, therefore, the sulfur limit will either have to be raised or this item stricken out altogether and the effect cared for in some other way.

After a number of meetings on the part of the Sub-Committee on Locomotive Cylinders, a satisfactory revised set of specifications was drawn up and duly presented at a general meeting of Committee A-3, called for that purpose. The vote of the committee by letter ballot on these specifications is as follows: affirmative, 24; negative, 2; not voting, 19. The committee therefore recommends that the proposed Revised Standard Specifications for Locomotive Cylinders appended hereto[1] be

[1] See 1914 Year-Book, pp. 238-244.—Ed.

adopted by the Society, to supersede the present Standard Specifications for Locomotive Cylinders, pages 216–217 of the 1913 Year-Book.

The revised specifications for malleable castings have not quite arrived at this point. There has been a marked change in the line of castings made of this material, the steel casting industry now claiming nearly all the heavy work. Hence the tendency in the foundries to operate for light casting work only, with consequent inability to make safe heavy castings from the same heats. This situation requires all the more attention in the revision of the standard specifications as, particularly in railroad work, there may be life at stake. So while proposed revised standard specifications for malleable castings have been duly prepared, they are still in the hands of the sub-committee for a further study of the situation, and it is expected that these will soon be reported to the main committee.

During the year, the two members of Committee A-3 constituting the American representation on the International Committee 1(*b*) on Cast Iron and Cast Iron Products, have been quite active, the work accomplished being detailed in the report given in Appendix I, with its four Appendices A, B, C and D. Pending the expected action by the coming St. Petersburg Congress on the proposed International Specifications for Pig Iron, Cast-Iron Pipe, and an International Test Bar—all intended for export use only—the committee is marking time on these subjects in so far as they relate to a possible revision of its own standard specifications.

This report has been submitted to letter ballot of the committee, which consists of 45 members, of whom 18 have voted affirmatively, 2 negatively, and 25 have refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

G. C. DAVIES,
Secretary.

[NOTE.—The proposed revised Standard Specifications for Locomotive Cylinders, as amended at the annual meeting (see page 20) were adopted by letter ballot of the Society on September 10, 1914, and appear on pages 238–241 of the 1914 Year-Book.—ED.]

APPENDIX I.

PROGRESS REPORT OF THE AMERICAN MEMBERS OF INTERNATIONAL COMMITTEE 1(*b*) ON SPECIFICATIONS FOR CAST IRON.

The American members of International Committee 1(*b*) take great pleasure in reporting that the first definite steps have been taken looking toward standard international specifications, in so far as these may serve the world's export trade.

It will be recalled that the question of making international specifications or in fact specifications of any kind—part of the duties of the International Association for Testing Materials—was originally presented at the Buda-Pesth Congress in 1901 by the three American members present—namely, Prof. H. M. Howe, and the undersigned. This matter has been urged upon the Association at each succeeding Congress, but as the underlying idea was the unification of the several national standard specifications, it was difficult to interest the various countries involved sufficiently to consent to the changes required in their own standards to accomplish the purpose in view. The palliative of an endorsement by the International Association of existing national specifications, for export, fortunately did not prevail, as this would have retarded progress indefinitely, and would eventually have allowed the weakest specifications to govern.

Nevertheless, our European friends, even if skeptical of definite accomplishment, were interested. The government control existing in most countries, the tender care exhibited for home interests when striving for trade abroad, the manner of converting raw materials into finished product in use in one country as contrasted with that of another; all these things make any action looking toward international unity a matter of years, if not the passing of generations. When, therefore, we advanced the idea of uniting on standard international specifications for export only, our European friends immediately began to take notice.

Here was an opportunity, while leaving the existing national specifications intact, to agree upon specifications for use by all nations in exporting, while not interfering with home methods and markets.

That the above suggestions did not take root at once may be imagined, and as it was difficult to agree through the medium of correspondence, we requested a meeting of the committee to be held last summer. Even this proving difficult, we crossed to the other side, met the chairman and committee members individually, and finding the greatest cordiality and personal understanding of the matter at issue, we prepared for the meeting duly called for Brussels December 5, 1913.

Taking all existing national and other specifications for pig iron, cast-iron pipe, and the test bar for gray iron castings, we prepared a draft of the American proposals for the proposed international export specifications. This was duly presented at the Brussels meeting. Previous to this meeting, however, special visits were made to certain influential members of the International Association in England, Germany, Austria, France, Belgium and Italy, to discuss the problem with them, and to get their views and suggestions. We are happy to say that we secured their support in almost every instance. The gentlemen visited communicated with their national representatives and consequently when the meeting was convened a pretty definite understanding of the situation prevailed from the first. Unfortunately the English members at the last moment were unable to attend the Brussels meeting, but promised to take the committee action under advisement, which they have done, as will be seen later.

The underlying thought of the Brussels conference was this: Every nation can best prepare its own standard specifications for materials of construction for home consumption. Home consumers know the conditions of manufacture in their own countries, can engage unattached experts to see that the requirements are met and that material of unquestioned quality is delivered. The small consumer in South America, Africa, or some other non-producing country is not in this happy position. He should be given standard specifications agreed to by the producing nations as fair and calculated to give him what he

requires—and this on a basis of equality in matters competitive. Only an *international* association is in a position to draw up such specifications, and it seemed that Committee 1(*b*) should make the start with items upon which international agreement was possible.

At the Brussels meeting there were adopted three standard specifications as the proposals of the committee to be presented to the Council of the International Association. This represents majority action. The English members subsequently presented a minority report to the Council, which will be referred to later. The first proposal is for pig iron (Appendix A). This represents practically the American Standard Specifications for Pig Iron, enlarged to cover also pig iron for malleable and steel casting purposes, and to include practically all the European irons going into the world's markets. The question of sampling and standard methods of analysis was referred to a special sub-committee consisting of the members for England –both expert chemists of international repute—the chief of the laboratories of Krupp, for Germany, and the representative of the United States Bureau of Standards, for America. The work already accomplished along this line by the American societies interested will naturally form a conspicuous part in this international investigation.

The next specifications are those applying to a proposed international test bar for cast iron (Appendix B). Our standard arbitration bar was changed from 1.25 to 1.20 in. diameter, so as to come into agreement with the metric system, and the testing is to be done with supports 18 in. instead of 12 in. apart, to accord more nearly with European practice. If finally adopted by the International Association, this will form the standard international test bar for arbitration purposes in cases of dispute and for general testing for export work.

Finally there are the proposed Standard Specifications for Cast-Iron Pipe and Fittings (Appendix C). These accord very nearly with the American standard specification, and contain such changes as were necessary to satisfy European conditions of production and yet ensure absolutely reliable material.

For the information of the Society the above proposals are all appended to this report. Again, as above stated, these proposals represent the work of the American and German

members of the committee, and have also the endorsement of the French and Belgian interests affected. The proposals for pipe are not fully acceptable to the English consumers, as they differ slightly from the standard English practice; but they are satisfactory to the British pipe founders, as their official representative sent to the Brussels meeting had a hand in shaping them. The proposals for the standard international test bar are satisfactory to all concerned, the English members having only reserved the right of suggesting minor modifications. The proposals for pig iron have not been accepted by the English members, who have presented a counter-proposal, which is given in Appendix D. Our American blast-furnace and foundrymen will be highly interested in this proposal, and it is to be hoped that the British Foundrymen's Association will have something to say on the subject before long.

After the Brussels meeting of the committee, the American members took the proposals adopted to London, meeting with the English members and representatives of the manufacturing interests. After a thorough discussion of the situation, the English members of the committee reserved their action, and subsequently arranged for meetings of the English interests as well as corresponded with the English iron experts on the subject of the proposed standard international test bar. The result was that the English member of the Council of the International Association was in effect to ask for a delay in Council action on the whole matter. This necessitated prompt action on our part, and our American member of the Council, Mr. H. M. Howe, then in Europe, was communicated with, urging strong representations to the Council for definite action towards placing the whole matter before the St. Petersburg Congress in 1915. By a resolution passed at the New York Congress the committees on international specifications had been requested to continue their work and to report to the Council from time to time. Mr. Moldenke of your committee sailed immediately and arrived in Turin three hours before the Council meeting at which this point was to be settled. His purpose was to supply Mr. Howe with any information on the Brussels action that might be wanted. Mr. Howe was good enough to arrange for his reception by the Council as a guest during the consideration of this particular

matter, and thus in its discussing with the individual members of the Council the American standpoint was better appreciated.

The report of Chairman Bruegmann of Committee 1(*b*) was duly acted upon, and the following resolution was adopted: "That the work of Committee 1(*b*) be continued, and the results so far attained be immediately issued in the Transactions of the Association, to render an exchange of opinion possible before the St. Petersburg Congress."

It is also interesting to note that the Council decided to add the words "Specifications for Export" to Problems 1(*a*) and 1(*b*).

Probably the most important action at the Council meeting was the adoption of a strong resolution definitely committing the Association to the preparation of international specifications for export purposes, the text of this being given in Mr. Howe's report on the subject at this meeting.

The American members of Committee 1(*b*) feel that the trail has now been blazed, and that the other committees should push along with proposals for international export specifications for other materials of construction. By concerted action, particularly as the majority of the European nations interested are now in accord with our aims in this respect for the good of the world, the St. Petersburg Congress for 1915 should see another milestone placed on the road of international friendship and advancement.

Respectfully submitted,

WALTER WOOD,
RICHARD MOLDENKE.

APPENDIX A.

Proposals for International Export Specifications for Pig Iron.

(Adopted at Brussels Meeting, December 5, 1913.)

1. It is proposed that for international trading purposes in pig iron, the analysis be taken as the basis, inasmuch as the value depends upon its content.

2. The following specifications for pig iron are recommended where the customary trade designations are insufficient (see tables below). For silicon a variation of 0.25 from analysis asked for, either way, shall be allowable. For sulfur and phosphorus the maxima given shall govern. For manganese a variation of 0.20 either way shall be allowable.

Silicon. [1]

Per Cent.	Code.
0.50	La
0.75	LaX
1.00	Le
1.25	LeX
1.50	Li
1.75	LiX
2.00	Lo
2.25	LoX
2.50	Lu
2.75	LuX
3.00	Ly
3.25	LyX
3.50	Lh
3.75	LhX

Sulfur.

Maximum Per cent.	Code.
0.02	Sa
0.03	Se
0.04	Si
0.05	So
0.06	Su
0.07	Sy
0.08	Sh

[1] Variation 0.25 either way allowable.

PHOSPHORUS.		MANGANESE.[1]	
MAXIMUM PER CENT.	CODE.	PER CENT.	CODE.
0.050	P	0.20	Ma
0.100	Pa	0.40	Me
0.250	Pe	0.60	Mi
0.500	Pi	0.80	Mo
0.750	Po	1.00	Mu
1.000	Pu	1.25	My
1.500	Py	1.50	Mh
2.000	Ph		

[1] Variation 0.20 either way allowable.

It was resolved that the code words above given are to be specially recommended as most useful for international commerce in pig iron.

3. That the Council of the International Association for Testing Materials be requested to appoint a standing committee of chemists who shall draw up international standard methods of sampling and analysis of pig iron; and that the Council ask the Verein Deutscher Eisenhuttenleute, the Engineering Standards Committee, and the American Society for Testing Materials, to delegate suitable members to serve on this committee

APPENDIX B.

Proposals for International Export Specifications for the Cast-Iron Test Bar.

(Adopted at Brussels Meeting, December 5, 1913.)

1. In order to obtain a reasonable uniform test bar (arbitration bar) for judging the qualities of iron poured into castings with reference to existing systems of measurement, a round bar shall be selected for testing transversely on supports 18 in. (45 cm.) apart. The diameter of this bar shall be 1.2 in. (30 mm.), the relation of length to diameter being 15 to 1 as nearly as may be.

2. The bars shall be cast in dry sand molds, vertically and with top pour. They shall be cast 20 in. (50 cm.) long, and be rounded at the bottom. The load in testing shall not be applied faster than 3 seconds for every hundredth part of the diameter. For every specification mixture two molds with three test bars each shall be cast, the bars to be cold before removal from the molds which should have attained the shop temperature before pouring. The bars shall be brushed clean and not rumbled.

APPENDIX C.

Proposals for International Export Specifications for Cast-Iron Pipe and Fittings.

Note.—All measurements shall be stated in English and metric figures; pressures in pounds and atmospheres.

(Adopted at Brussels Meeting, December 5, 1913.)

Description of Pipe.

Section 1. The pipe shall be made with socket and spigot joints, or with flanges, and shall accurately conform to the dimensions given in the tables. They shall be straight and true cylinders with their inner and outer surfaces concentric, and shall be of the specified dimensions in outside diameter.

When the length for a pipe is stated it is understood to be at least the "laying length."

Whenever pipe of thicker section are required, the increase of thickness may be obtained by reducing the bore, so as to maintain the outside diameter constant.

These specifications also apply to turned and bored pipe.

Turned and bored pipe shall be machined accurately so as to make water-tight joints. When the pipe are driven together the spigots shall come within $\frac{5}{8}$ in. of the shoulder of the socket.

Flanged pipe shall be faced on wide strips, straight across, or with check joints, as ordered. Bolt holes may be drilled or cored.

Allowable Variation in Pipe and Sockets.

Section 2. The diameter of the spigot ends and sockets of the pipe shall not vary from the standard dimensions by more than the following amounts:

0.12	in.	for pipe	16	in.	or less	in	diameter	
0.16	"	"	"	18	"	—24	in.	"
0.20	"	"	"	30	"	—42	"	"
0.24	"	"	"	44	"	—48	"	"
0.30	"	"	"	54	"	—61	"	"

ALLOWABLE VARIATION IN THICKNESS.

SECTION 3. For pipe the standard thickness of which is less than 1 in., the thickness of the metal in the body of the pipe shall not be 0.12 in. less than the standard thickness; for pipe thicker than 1 in., this deviation shall not exceed 0.15 in., except that for spaces not exceeding 8 in. in length in any direction an additional variation of 0.02 in. shall be permitted.

These variations refer to castings from standard patterns.

For fittings a variation of 25 per cent greater than allowed for straight pipe shall be permitted.

CUTTING SPIGOTS.

SECTION 4. All pipe cast socket down must be made with a sink head on the spigot end, to be cut off in a lathe, leaving the pipe of the standard "laying length." It shall be permissible to supply 5 per cent of the total order of pipe in lengths not over 10 per cent shorter than the standard length.

FITTINGS.

SECTION 5. Fittings shall be made in accordance with dimensions given in the tables provided.

The internal diameters of the sockets and external diameters of the spigots shall not vary from the standard dimensions by more than the following amounts:

0.12	in.	for pipe	16	in.	or less	in	diameter	
0.16	"	"	"	18	"	—24	in.	"
0.20	"	"	"	30	"	—42	"	"
0.24	"	"	"	44	"	—48	"	"
0.30	"	"	"	54	"	—60	"	"

These variations apply only to fittings made from standard patterns.

MARKING.

SECTION 6. The inspector shall mark each pipe with its class and number, also his initials, showing its acceptance. The weight shall be conspicuously painted in white on each pipe and fitting after the coating has become hard.

ALLOWABLE PERCENTAGE OF VARIATION IN WEIGHT.

SECTION 7. No pipe shall be accepted the weight of which is more than 5 per cent less than the standard weight. No excess above the standard weight of more than 5 per cent shall be paid for.

When pipe are cast to order, the total weight to be paid for under the contract shall not exceed the total of the standard weights of the whole order by more than 2 per cent.

No fittings need be accepted which are under the standard weight by more than 10 per cent for pipes 12 in. or less in diameter, and 8 per cent for larger sizes, except that curves, Y-pieces and breeches pipe may be 12 per cent below the standard weight; and no excess above the standard weight of more than the above percentages for the several sizes will be paid for.

These variations apply only to castings made from standard patterns.

QUALITY OF IRON.

SECTION 8. All pipes and fittings shall be made of cast iron of good quality and of such character that the metal in the castings shall be strong, tough and of even grain, and soft enough to satisfactorily admit of drilling and cutting.

These specifications refer to iron remelted in the cupola, and not to metal taken direct from the blast-furnace, or mixed iron, for the use of which special sanction must first be obtained and suitable regulations agreed upon.

TESTS OF MATERIALS.

SECTION 9. Of the metal used, specimen bars, 26 in. long by 2 in. wide and 1 in. thick, shall be made without charge as often as the engineer may direct, and in default of definite instructions, the founder shall make and test at least one bar from each heat or run of metal. The bars, when placed flat-wise upon supports 24 in. apart, and loaded in the center, shall support a load of 2000 lb., and show a deflection of at least 0.30 in. before breaking. The founder shall have the right to make and break three bars from each heat or run of metal, and the test shall be based upon the average results of the three bars. Should the dimensions of the bars differ from those given above, a proper allowance therefor shall be made in the results of the tests.

CASTING OF PIPE.

SECTION 10. The straight pipe shall be cast in dry sand molds in a vertical position. All pipe shall be cast with the socket end down unless otherwise approved.

The pipe shall not be stripped or taken from the mold while showing color of heat, but shall be left in the flasks for a sufficient length of time to prevent unequal contraction by subsequent exposure.

QUALITY OF CASTINGS.

SECTION 11. The pipes and fitting shall be smooth, free from scales, lumps, blisters and holes, and defects of every nature which unfit them for use.

No plugging or filling will be allowed.

No pipes or fittings shall be rejected for faults which do not affect their usefulness for the work for which they are intended.

CLEANING AND INSPECTION.

SECTION 12. All pipes and fittings shall be thoroughly cleaned, and subjected to a careful hammer inspection. No casting shall be coated unless entirely clean and free from rust and approved in these respects by the engineer immediately before being dipped.

COATING.

SECTION 13. Every pipe and fitting shall be coated inside and out with coal-tar pitch varnish. The varnish shall be made from coal tar. To this material sufficient oil shall be added to make a smooth coating, tough and tenacious when cold, and not brittle or with any tendency to scale off.

Each casting shall be heated to a temperature of 100° C. immediately before it is dipped. The ovens in which the pipes are heated shall be so arranged that all portions of the pipe shall be heated to an even temperature. Each casting shall remain in the bath a sufficient time for proper coating.

The varnish shall be heated to a temperature of 300° F. and shall be maintained at this temperature during the time the casting is immersed.

Fresh varnish or oil shall be added when necessary to keep the mixture at the proper consistency. After being coated, the pipe shall be carefully drained of any surplus. Fittings shall be coated in the same manner as pipe unless impracticable because of dimensions.

HYDROSTATIC TEST.

SECTION 14. The straight pipes shall be subjected to proof by hydrostatic pressure, and, if required by the engineer, shall also be subjected to a hammer test under this pressure.

The pressures to which the different sizes and classes of pipes shall be subjected are as follows:

	20-in. Diam. and Larger, lb. per sq. in.	Less than 20-in. Diam., lb. per sq. in.
Class A pipe	150	300
Class B pipe	200	300
Class C pipe	250	300
Class D pipe	300	300

Fittings shall be hydrostatically tested when specifically required by special agreement, which shall state the amount of pressure that shall be applied.

WEIGHING.

SECTION 15. The pipes and fittings shall be weighed at the foundry for payment under the supervision of the engineer, who may at any time require the examination and certification of the accuracy of the weighing apparatus. Castings requiring machining shall be paid for at "casting weight." Tenders shall be submitted and final settlements made on the basis of weight.

FOUNDER TO FURNISH LABOR AND MATERIAL.

SECTION 16. The founder shall provide all tools, testing machines, materials and labor necessary for the required testing, inspection and weighing at the foundry of the pipe and fittings. Should the purchaser have no inspector at the works, the founder shall, if required by the engineer, furnish a sworn statement that all of the tests have been made as specified, this statement to contain the result of the tests upon the test bars.

POWER OF INSPECTOR.

SECTION 17. The engineer shall be at liberty at all times to inspect the material at the foundry, and the molding, casting and coating of the pipes and fittings. The forms, sizes, uniformity and condition of all pipes and other castings herein referred to shall be subject to his inspection and approval, and he may reject any pipe or other casting which is not in conformity with the specifications or drawings.

The inspector shall be fully competent to properly perform his duties, and must not retard the work of the pipe foundry by any neglect on his part, and if considered unfair and unreasonable in his inspection, the founder shall have the right to demand his removal and a competent and reasonable inspector placed on the work.

No pipes or fittings shall be rejected for faults which do not affect their usefulness for the work for which they are intended.

INSPECTOR TO REPORT.

SECTION 18. The inspector at the foundry shall report daily to the foundry office all pipe and fittings rejected, with the causes for rejection. A copy of the inspector's certificate to the engineer shall be simultaneously furnished the founder.

CASTINGS TO BE DELIVERED SOUND AND PERFECT.

SECTION 19. All pipe and other castings must be delivered in all respects sound and conformable to these specifications. The inspection shall not relieve the founder of any of his obligations in this respect, and any defective pipe or other castings which may have passed the inspector at the works or elsewhere shall be at all times liable to rejection when discovered, until the final completion and adjustment of the contract; provided, however, that the founder shall not be held liable for pipe and fittings found to be cracked after they have been accepted at the agreed point of delivery.

The manufacturer shall not be held responsible for any expenses or damages incurred in handling or using the castings. Any pipe or standard fitting that proves defective shall—when requested—be replaced by the maker, the measure of damage

not to exceed the value of the casting. The manufacturer shall have the right to call for the defective casting to be returned before any allowance is demanded.

DEFINITION OF "ENGINEER."

SECTION 20. Wherever the word "engineer" is used herein, it shall be understood to refer to the engineer or inspector acting for the purchaser and to his properly authorized agents, limited by the particular duties entrusted to them.

SPECIFICATIONS.

SECTION 21. The details of these specifications apply only to castings made from standard patterns. Any different or "special castings" ordered shall be in all regards subject to special agreement between buyer and seller.

DISPUTES.

SECTION 22. In the case of any disagreement upon the interpretation of any point arising out of these specifications, the matter may be referred by mutual agreement to an independent third party for decision.

APPENDIX D.

PROPOSAL OF THE ENGLISH MEMBERS OF COMMITTEE 1(*b*) FOR INTERNATIONAL EXPORT SPECIFICATIONS FOR PIG IRON.

Grade.	Silicon, per cent.	Sulfur, max., per cent.	Phosphorus, max., per cent.	Manganese, per cent.
1	2.5–3.5	0.05	1.75	0.4–1.0
2	2.0–3.0	0.08	1.75	0.4–1.0
3	1.5–2.5	0.12	1.75	0.4–1.0

DISCUSSION ON THE REPORT OF COMMITTEE A-3.

Mr. Moldenke. MR. RICHARD MOLDENKE (*Chairman of Committee A-3*).—In pursuance of a criticism that has been received on the proposed revised Standard Specifications for Locomotive Cylinders, I wish to move, on behalf of the committee, the addition of the following sentence at the end of Section 6 (*a*) of these specifications with reference to the test bar:

"It shall not be rumbled or otherwise treated, being simply brushed off before testing;"

and that the specifications, as thus amended, be referred to letter ballot of the Society.

[This motion was carried.]

Mr. Waldo. MR. LEONARD WALDO.—I note that the committee contemplates top pouring test bars. I presume they have good commercial reasons for doing that, but it has been my observation that a test bar poured from the top is not apt to be as homogeneous or as good as a bottom-poured bar. In a bottom-poured bar, the fluid metal through the side gate acts as a slag catcher, the metal rising on the other side. I do not think that the thermal condition of the hot or cold mold has much effect in producing the beautiful and much more homogeneous metal secured by bottom pouring. I should like to ask why the test bar is poured from the top and not from the bottom.

Mr. Moldenke. MR. MOLDENKE.—This matter goes back to one of the fundamental points considered in the preparation of the original standard specifications for the test bar. If you will cast a number of them flat, and in testing transversely will place half the bars on the supports cope side up, and the other half cope side down, you will get a considerable difference in strength in the results. As the iron is poured, the hot metal runs along the bottom of the mold, heating up this part of the sand, and at the same time cooling off the metal. Thus the hottest metal comes in contact with the hot sand, the comparatively cold iron rising to the top and touching the cold sand. This causes a difference in the

strength of the metal at the top and bottom. For that reason we wished to get away from the uncertainty of flat pouring and chose the vertical position for the test bar. Mr. Moldenke.

Now as to the molding problem. It is necessary to teach the men how to mold the test bar properly, for if the sand is not carefully rammed, the lower portion of the bar will swell heavily. I have a small foundry in my residence, and until my Italian laborers got the knack of ramming the sand properly, the test bars came out looking like Indian clubs. The Germans are able to pour a test bar 24 in. long vertically with perfect success; hence we should surely have no difficulty with our shorter bar.

MR. T. D. WEST.—This discussion carries me back to the early history of test bars and the time when the Western Foundrymen's Association of Chicago first took up this matter. A committee on test bars was appointed of which I was a member and I was charged with designing the test bar and recommending a method of testing this bar. Although my experience indicated the difficulty and risk in pouring test bars from the bottom, I first attempted, nevertheless, to make them in this way. The bars were $1\frac{1}{4}$ in. in diameter. Some were made in dry sand and some in green sand. The bars looked very well and they were sent to Chicago to be tested, one of the objects being to have a round bar adopted as a standard. I witnessed these tests. A microscope showed little particles of dirt which were so small in some cases that they could not be seen with the naked eye, and the bars were condemned by the committee. Mr. West.

Another set of bars was then made by top pouring which proved entirely satisfactory. The superior value of top pouring as compared with bottom pouring, especially in making large cylinders, is well known to experienced founders. I have made hollow cylinders some 16 ft. high by top pouring which when finished on the inside showed not even a pin hole. Such perfect castings could not have been secured by bottom pouring.

MR. MOLDENKE.—The best results in making cylinders are obtained by providing the mold with a circular pouring basin on the top, in which is a series of small "pop-gates" for allowing the molten iron to drop down straight to the bottom all around the mold at the same time. This results in quiet Mr. Moldenke.

Mr. Moldenke. metal rising steadily upward to fill the mold, and gives perfectly clean sound iron cylinder castings.

Mr. Wood. MR. WALTER WOOD.—Reinforcing that statement of Mr. Moldenke, it is perhaps only necessary to say that 95 per cent of the cast-iron pipes made in this country, about 13 or 14 ft. long, are top poured. We find that it gives a good casting and it is customary to follow that method regularly, except in very heavy castings for which it is desirable to put a little metal into the bottom of the mold to take the shock of the falling metal which otherwise might cut the sand.

I want also to emphasize what Mr. Moldenke has said as to securing international specifications. Those who have this in charge, must understand their work thoroughly, and they must go at it with a great deal of unselfishness—with absolute unselfishness as to any particular result. They must also exercise considerable ingenuity and diplomacy to overcome the little things which come up. Little turns of expression and terms which one country may have used for years must be adapted to changes which another country may desire. But after all the chief thing is to secure the cooperation of those with whom you are going to work, by letting them know you personally, know your reasons, and know what you hope to get, without being apparently too insistent upon your own views. In this way you will in the end carry your own points successfully.

Mr. Hunnings. MR. S. V. HUNNINGS.—Regarding the top pouring of test bars, I should like to state that we are casting thousands of them every year, and that we have no trouble in securing sound test bars. I know that this has also been the experience of the Baldwin Locomotive Works, so I do not think we need worry about whether it is possible to obtain sound top-poured test bars. If it was a matter of much consequence, that is, if we were having cylinders rejected on account of unsound or dirty test bars, we should be the first to advocate bottom pouring. In view of these facts I do not think there is any necessity for considering bottom pouring of the arbitration test bars.

Mr. Johnson. MR. J. E. JOHNSON, JR.—There is no doubt that the convenience of making top-poured bars far offsets any advantage that the bottom-poured bar might have, allowing, for the sake of argument, that it has any. Cast iron is not an absolutely

definite material, as steel of a given composition is, and it is necessary to have a good many bars to get the average result, rather than to tie all our hopes to one test piece, as can be done with reasonable safety for ordinary steel. Commercial considerations make it absolutely necessary, on that account, to use the top-poured bar. Mr. Johnson.

In regard to the specifications for cast iron, it seems to me a pity that they are so indefinite. There is a great deal of work being done on cast iron, and a great deal has been found out about it that does not seem to appear in these specifications. In this matter of locomotive cylinders, the question of the strength of iron outside of its ordinary analysis has been investigated to a very great extent, and results have been obtained which have been accepted very widely outside of the Society and, in fact, by some of the members of the Society. It seems to me that more account should have been taken of these later developments. Mr. Moldenke's whole thesis is along the line that it is perfectly archaic to use fracture in judging cast iron. To a certain extent and within certain limits, that is true, but there is a great deal to be told by the fracture of iron of a given analysis that you cannot tell from the analysis alone. I venture to say there is not a foundryman in this room but who will bear me out in saying that iron will vary as much as 50 per cent in strength on a given analysis for all the ordinary elements, and that variations by fracture can be seen very plainly by a reasonably experienced man. If you are not going to have rigid specifications for strength for work that demands strength, it is necessary to go back to fracture in addition to analysis, or else to complete the analysis and determine what it is that causes irons to vary in the way they do. I have seen two irons of absolutely identical analysis made from the same furnace and the same ores and practically the same in all respects, apparently, but one of those irons would break at 2700 lbs. and the other at 5000 lbs., for a $1\frac{1}{4}$-in. bar. The grain of one was like sugar and that of the other like silk, but they had the same analysis in all the ordinary elements. I don't think you can afford to adopt specifications without paying attention to facts which stick out like that.

Mr. Moldenke.—The bars had the same analysis, you say? Mr. Moldenke.

Mr. Johnson. MR. JOHNSON.—Yes, sir.

Mr. Moldenke. MR. MOLDENKE.—Did they have the same combined carbon and graphite?

Mr. Johnson. MR. JOHNSON.—They had very nearly the same combined carbon and graphite and the analysis in other respects was the same.

Mr. Moldenke. MR. MOLDENKE.—I should like to see those bars.

Mr. Johnson. MR. JOHNSON.—I can show them to you.

REPORT OF COMMITTEE A-4
ON
HEAT TREATMENT OF IRON AND STEEL.

Committee A-4 has confined its activities during the past year to the preparation of Proposed Recommended Practice for the Annealing of Carbon-Steel Castings. This has been drawn up in accordance with the views of the members as expressed in discussion, and was agreed upon in its present form at a meeting held in New York City. Upon letter ballot of the committee on this proposed recommended practice, 11 members voted affirmatively, none negatively, and 1 refrained from voting. The committee recommends that this practice, which is appended to this report,[1] be referred to letter ballot of the Society for adoption.

At the meeting in New York it was voted to recommend that the Proposed Recommended Practice for the Heat Treatment of Case-Hardened Carbon-Steel Objects, included in the last report of this committee,[2] be referred to letter ballot of the Society for adoption. The report of the committee last year, embodying this practice, was forwarded too late to be submitted to the Society for adoption. Upon letter ballot on this practice last year, 7 members voted affirmatively, 1 negatively, and 4 refrained from voting. For convenience of reference, the proposed recommended practice has been appended to this report.[3]

This report has been submitted to letter ballot of the committee, which consists of 12 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

ALBERT SAUVEUR,
Chairman.

JOHN H. HALL,
Secretary.

[NOTE. –The two proposed Recommended Practices referred to in the above report were adopted by letter ballot of the Society on September 10, 1914, and appear on pages 205–208 of the 1914 Year-Book.—ED.]

[1] See 1914 Year Book, pp. 205–206.—ED.
[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 188 (1913).
[3] See 1914 Year-Book, pp. 207–208.—ED.

REPORT OF COMMITTEE A-6

ON

MAGNETIC TESTING OF IRON AND STEEL.

Committee A-6 has held two well-attended meetings, and has had considerable correspondence to consider what changes or additions to the Standard Magnetic Tests of Iron and Steel, pages 157–161 in the 1913 Year-Book, may be desirable.

After mature deliberation, the committee recommends that the following amendments be made:

1. On page 159 after line 6 insert the following:

"*Sampling.*—The core-loss material shall be cut from two or more sheets taken at random from the shipment. The strips should be distributed symmetrically over the sheet, as nearly as may be practicable. For example, see Figs. 1 and 2.

"It is recommended that a test sample shall represent not more than 5000 kg. (11,000 lb.)."

2. On page 159, lines 7-9, change:

"Cut from the test material a number of strips 3 by 50 cm., half parallel and half at right angles to the direction of rolling.",

to read:

"Cut the test material into strips 3 by 50 cm. as indicated under 'Sampling'."

3. On page 160, lines 7-8, change:

"The test material shall consist of 5 kg. of the strips cut as indicated for the standard core-loss test.",

to read:

"The permeability sample for sheet material shall consist of an even number of strips cut parallel to the direction of rolling and an even number cut perpendicular to this direction, selected from material sampled as for core loss.

"The sample shall weigh not less than 1 nor more than 2 kg."

FIG. 1.

FIG. 2.

A considerable amount of work has been done looking to more detailed specifications for testing permanent magnet steel, but no definite report is ready on this subject as yet.

This report has been submitted to letter ballot of the committee, which consists of 12 members, of whom 10 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

CHARLES W. BURROWS,
Chairman.

[NOTE.—The proposed amendments in the Standard Magnetic Tests of Iron and Steel were adopted by letter ballot of the Society on September 10, 1914. The tests as amended appear on pages 193–198 of the 1914 Year-Book.—ED.]

REPORT OF COMMITTEE A-8

ON

STANDARD SPECIFICATIONS FOR COLD-DRAWN STEEL.

The committee submitted to the Society last year two specifications, one for Bessemer Automatic Screw Stock and the other for Open-hearth Automatic Screw Stock, and recommended that these be published as tentative specifications, which was done. The Tentative Specification for Bessemer Automatic Screw Stock has been given a somewhat extended test during the last year by various members of the committee, and on the basis of this experience the committee recommends that this specification, appended hereto,[1] be submitted to the Society for adoption as standard.

The experience with the Tentative Specification for Open-hearth Automatic Screw Stock has been less extensive. The committee has further voted some slight changes in the chemical composition required in this specification, and recommends that this specification, in its revised form as appended, be continued as a tentative specification for another year. The modification adopted by the committee in the chemical composition is to change Section 3 from its present form, namely:

"3. The steel shall conform to the following requirements as to chemical composition:

Carbon	0.15 – 0.25	per cent
Manganese	0.60 – 0.90	"
Phosphorus	not over 0.05	"
Sulfur	0.075 – 0.12	"

to read as follows:

"3. The steel shall conform to the following requirements as to chemical composition:

[1] See 1914 Year-Book, pp. 167–168.—Ed.

Carbon	0.15 – 0.25	per cent
Manganese	0.60 – 0.90	"
Phosphorus	not over 0.06	"
Sulfur	0.075 – 0.15	"

The committee would be very glad to have the cooperation of the interested members of the Society in getting information as to the suitability of material purchased in accordance with these specifications for their particular purposes. Such information should be sent to the chairman.

This report has been submitted to letter ballot of the committee, which consists of 13 members, of whom 12 have voted affirmatively and 1 negatively.

Respectfully submitted on behalf of the committee,

C. E. Skinner,
Chairman.

[Note.—The proposed Standard Specifications for Cold-Drawn Steel: Bessemer Automatic Screw Stock, were adopted by letter ballot of the Society on September 10, 1914, and appear on pages 167–168 of the 1914 Year-Book.

The Tentative Specifications for Cold-Drawn Steel: Open-hearth Automatic Screw Stock, follow this report.—Ed.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR COLD-DRAWN STEEL.[1]

OPEN-HEARTH AUTOMATIC SCREW STOCK.

Material Desired.

1. These specifications cover a free-cutting steel of any specified section suitable for high-speed screw machine work, leaving a smooth finish after machining.

I. MANUFACTURE.

Process.

2. The steel shall be made by the open-hearth process, and shall be cold-rolled or cold-drawn or turned to size.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

3. The steel shall conform to the following requirements as to chemical composition:

Carbon	0.15 – 0.25 per cent
Manganese	0.60 – 0.90 "
Phosphorus	not over 0.06 "
Sulfur	0.075 – 0.15 "

Test Samples.

4. Samples for analysis shall be taken by machining off the entire cross-section of the bar, or by drilling parallel to the axis of the bar at any point midway between the center and surface

[1] Criticisms of these Tentative Specifications are earnestly requested and should be directed, preferably before January 1, 1915, to Mr. C. E. Skinner, Chairman of Committee A–8, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

with a drill not under $\frac{1}{2}$ nor over $\frac{3}{4}$ in. in diameter. Samples shall be clean, free from oil, uniformly fine and well mixed.

III. PERMISSIBLE VARIATIONS IN DIMENSIONS.

5. The variation from the specified diameter, or distance between parallel faces, and the allowable eccentricity shall not exceed the following limits: Permissible Variations.

PERMISSIBLE VARIATIONS.

Diameter.	Over-size.	Under-size.	Eccentricity.
Up to and including 0.3 in.....	0	1% of diameter	0.5% of diameter
Over 0.3 in. to and including 1 in...	0	0.003 in.	0.0015 in.
Over 1 in. to and including $2\frac{1}{2}$ in...	0	0.004 "	0.0020 "
Over $2\frac{1}{2}$ in.....	0	0.005 "	0.0025 "

IV. FINISH.

6. The material shall be free from injurious defects and shall have a bright smooth surface. Finish.

V. INSPECTION AND REJECTION.

7. The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. Inspection.

8. Material which fails to conform to the above specifications will be rejected, and the manufacturer shall be notified. Rejection.

REPORT OF COMMITTEE B-1

ON

STANDARD SPECIFICATIONS FOR COPPER WIRE.

Committee B-1 has held one meeting during the year, at which there were seven members present, the four absent having given notice of inability to attend.

During the year, work has been continued on the preparation of specifications for copper trolley wire, in conjunction with a sub-committee representing the Power Committee of the American Electric Railway Engineering Association. This work has been carried on by a sub-committee of Committee B-1. Several joint meetings were held and a number of tests were made. Finally, the sub-committee reported proposed specifications which seemed to represent the nearest approach to a satisfactory compromise which then appeared possible between the two sub-committees. There are several points at issue between the two bodies on which differences of opinion are rather radical, and nearer approach to agreement does not seem possible with data now available as a guide. The proposed specifications have been very seriously considered by your committee, and it has finally voted unanimously not to report them to the Society at this meeting, but to hold them for further consideration in connection with data on the subject of trolley-wire service and requirements which your committee hopes to collect during the next few months.

While the difficulty of obtaining definite data upon which to determine the requirements of copper wire necessary to give the most satisfactory service as trolley wire is fully realized, it is to be the endeavor of the committee to collect as much data as possible, when the matter will be taken up again with the Power Committee of the Electric Railway Association.

In the standardization rules of the American Institute of Electrical Engineers, which will undoubtedly be adopted this year, the Standard Specifications for Copper Wire of the American Society for Testing Materials are referred to as the suggested

basis of purchase of copper wire. The standards adopted by the Institute are those of the International Electrotechnical Commission covering the standard resistivity of annealed copper wire, including the temperature coefficient of resistance, etc. This reference to the specifications of the American Society for Testing Materials as the suggested basis of purchase of copper wire completes the Institute's rules, and is as near a formal adoption of the Society's specifications as is permissible under the organization of the Institute.

The committee has no recommendations to make covering changes in the existing specifications under its charge.

This report has been submitted to letter ballot of the committee, which consists of 11 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. A. Capp,
Chairman.

REPORT OF COMMITTEE B-2

ON

NON-FERROUS METALS AND ALLOYS.

Committee B-2 has held one meeting, at which ten members were present and the proxies of four members were held by those present. The following changes were recommended:

Standard Specifications for Spelter.

(Page 248 in the 1913 Year-Book.)

1. In Section 7, under *Cadmium*, line 9, change "dissolve in 10 cc." to read "dissolve by boiling in 10 cc."

Standard Specifications for Manganese-Bronze Ingots.

(Page 252 in the 1913 Year-Book.)

1. Change the title from:

"Standard Specifications for Manganese-Bronze Ingots."

to read:

"Standard Specifications for Manganese-Bronze Ingots for Sand Castings."

2. Change Section 1 from:

"1. This specification is intended to cover manganese-bronze ingots, having notched flat bottoms, approximately 3 by $2\frac{3}{4}$ in. wide by 12 in. long, properly tapered to strip easily from an iron mold.",

to read:

"1. This specification is intended to cover the copper-zinc alloy, known commercially as manganese-bronze, in the form of ingots having notched flat bottoms, approximately 3 by $2\frac{3}{4}$ in. wide by 12 in. long, properly tapered to strip easily from an iron mold."

3. Change Section 2 from:

"2. The chemical composition shall be as follows:

Copper	55 to 60.0	per cent
Zinc	39 to 45.0	"
Iron	not over 2.00	"
Tin	" " 2.00	"
Aluminum	" " 0.5	"
Manganese	" " 0.5	"

to read:

"2. The chemical composition shall be as follows:

Copper	53 to 62.00	per cent
Zinc	36 to 45.00	"
Aluminum	0.05 to 0.5	"
Lead	not over 0.15	"

with such other alloying constituents, as iron, tin, manganese, etc., as may be necessary to meet the physical requirements specified in Section 3."

4. Change Section 6 from:

"6. Each furnace charge shall be kept separate until the lot is sampled by the inspector, and each ingot thereof stamped with its proper heat number. When the ingot is sampled at destination, various heats can be mixed in shipment, but must be stamped with their proper heat number.",

to read:

"6. Each ingot shall be stamped with its proper heat or charge number."

While the amount of work accomplished is apparently small, the difficulties under which the committee is working are by no means negligible. Mr. W. R. Webster, Chairman of Sub-Committee II, has pointed out some of them in his paper on "Considerations Affecting Specifications for Wrought Non-Ferrous Materials.[1] Sub-Committee I on Pure Metals has under consideration specifications for lead and for tin. The Sub-Committees on Sand-Cast Metals and Alloys and on White Metals, have been confronted with the difficulties of obtaining

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part II (1914).

suitable test specimens and uniform samples for analyses. In order to avoid duplication of work it has been decided to wait for the results of the researches being carried on at the Bureau of Standards, to the Advisory Committee of which several of the members of the committee belong. As soon as methods of obtaining representative test specimens and uniform samples for analytical work have been devised, rapid progress can be made in formulating numerous standard specifications.

This report has been submitted to letter ballot of the committee which consists of 25 members, of whom 19 have voted affirmatively, 2 negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

WILLIAM CAMPBELL,
Chairman.

[NOTE.—The proposed amendments in the Standard Specifications for Spelter and for Manganese-Bronze Ingots were adopted by letter ballot of the Society on September 10, 1914. The specifications as amended appear on pages 284–289 of the 1914 Year-Book.—ED.]

DISCUSSION.

Mr. G. H. Clamer. It might be well to offer a little explanation why this change in composition of manganese bronze is proposed. The original specification recommended by the committee referred merely incidentally to a copper-zinc alloy and gave no stipulation as to the composition. It was a performance specification only, leaving it to the manufacturer to make the composition as he saw fit. Objection was raised to this specification, and very rightly, too, that it contained nothing which would prevent the manufacturer from furnishing steel which would meet the physical properties, except that the title of the specification referred to "manganese bronze." It was accordingly recommended that some stipulation governing the composition be incorporated in the specification, and it was therefore suggested that the specification should read: Mr. Clamer.

Copper	from	55	to 60	per cent
Zinc	"	39	" 45	"
Iron	not	over	2	"
Tin	"	"	2	"
Aluminum	"	"	5	"
Manganese	"	"	5	"

The objection to this specification was that the limit on tin was too high, for if the maximum tin percentage were used, the metal would fall short in the physical properties. It was therefore thought better to modify the specification again, by simply putting a limit on the metals which might prove detrimental if used in excess of the maximum limits and specifying the essential alloying constituents, leaving all other constituents to the manufacturer to add as he might see fit to meet the physical requirements. The specification as it now reads is, I think, in a very practical shape, allowing the manufacturer all the leeway which he requires to furnish ingots which are called for by the specification and which will meet the physical requirements.

Mr. Corse. MR. W. M. CORSE.—Mr. Campbell has asked me to say a word about the work of the Advisory Committee of the Bureau of Standards, which I am very glad to do, because it explains why Committee B-2 has no further report to offer. Representatives of the American Institute of Metals conferred with Mr. Stratton about two years ago, relative to some work on non-ferrous alloys, and he very heartily entered into an arrangement by which we could get the advantages of research work at the Bureau, and such work as our committee might outline. In order to avoid duplication we were to consult with other technical societies doing work in the same field. It was decided to form a committee of representatives from four or more leading technical societies: first, the American Institute of Mining Engineers, which is interested in the product up to the ingot shape; second, the American Institute of Metals, whose interest extends especially from the ingot shape to the finished casting; third, the American Chemical Society, which deals with the product in relation to its chemical analysis; and fourth, the American Society for Testing Materials, which is concerned about the specifications. We have had three meetings in Washington at the Bureau of Standards, the last one being an especially interesting and successful one.

Mr. Burgess has been appointed Chief of the Division of Metallurgy at the Bureau and has undertaken this work with a great deal of interest. I think we shall see that the cooperative work of this Society and the three others mentioned, with the Bureau, will prove very valuable. The Bureau of Standards is erecting a building at Washington, of which a part is to house a small foundry. This can be used in making experimental castings for these investigations. The duty of the Advisory Committee from the four societies will be to go over this work with the Bureau officials at meetings to be held about twice a year, and outline the practical problems that they desire. It is thought best to defer some of the work of Committee B-2 with a view of taking advantage of the results obtained from the proposed investigations at the Bureau of Standards. This is particularly true of the work on sand castings.

REPORT OF COMMITTEE C-1

ON

STANDARD SPECIFICATIONS FOR CEMENT.

As previously reported, upon invitation of Committee C-1, a Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement has been created and is engaged in reconciling differences in methods of tests and specifications for cement. Your committee has been represented at all meetings of this conference and has participated in its work. It is expected that the conference will report during the present year.

In anticipation of a possible revision of the Standard Specifications for Cement, your committee has deemed it desirable, in order that its membership may be thoroughly representative of the various interests, to increase its personnel as indicated in the appendix to this report,[1] from which it will be seen that the committee consists now of 34 non-producers and 10 producers.

The committee has also appointed a number of sub-committees, and has adopted the special regulations for its government contained in Appendix I.

At the last annual meeting of the Society, "on motion of Mr. Robert W. Lesley, with the approval of the author, Mr. Force's paper on 'Results Obtained with the Autoclave Tests for Cement,' was accepted with the understanding that it would be printed in the Proceedings and that it would be referred to Committee C-1 on Standard Specifications for Cement."[2] Since the adoption of this resolution a patent was granted to H. J. Force on February 3, 1914, for "A Method of Testing Portland and other Cements" (Patent No. 1,085,977).

Your committee has had the subject matter referred to in this resolution under consideration and it was discussed at a

[1] This appendix is not printed here. The personnel of the committee appears in the 1914 Year-Book, p. 428.—Ed.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 26 (1913).

meeting on December 2, 1913, at which Mr. George J. Ray, Chief Engineer, and Mr. H. J. Force, Chemist and Engineer of Tests, of the Delaware, Lackawanna and Western Railway Co., were present by invitation. Mr. Ray was subsequently added to the committee. At this meeting the secretary was instructed to send a letter to the various testing laboratories with a request that they state:

1. Whether or not they were conducting investigations of the autoclave test;
2. Requesting a copy of the program of the tests that were being made;
3. Requesting a copy of the results of tests thus far obtained;
4. Whether they would be willing to cooperate with the committee in a series of tests.

Responses have been received from all of the 16 laboratories to whom this letter was addressed, of which 11 stated they were making autoclave tests, 6 stated that they would be glad to furnish copies of the results thus far obtained, 9 agreed to furnish a copy of the final results, and 12 agreed to participate in a series of tests to be inaugurated by the committee.

The committee has appointed the following sub-committee to investigate the Accelerated Tests of Constancy of Volume of Cements:

Richard L. Humphrey, *Chairman;* Ernest Ashton; George J. Ray; F. E. Schall; S. S. Voorhees; George S. Webster.

In compliance with the resolution adopted at the meeting of The International Association for Testing Materials in New York in September, 1912, the Council of The International Association for Testing Materials created Commission No. 32 to report on Accelerated Tests of the Constancy of Volume of Cements, and at its meeting in Turin, Italy, April 3, 1914, appointed Mr. Richard L. Humphrey as chairman. This commission will contain several members from each of the principal countries of the world and contemplates a thorough investigation of all the accelerated tests of constancy of volume of cements. It is expected that Committee C-1 through its special sub-committee will participate in the work of the International Committee, and the plan to carry on experiments in each of the

various countries represented will undoubtedly produce data which may be reasonably expected will serve as a basis for definite recommendations.

In response to the invitation of the Executive Committee, your committee has designated the secretary as a representative to cooperate with representatives of other committees of the Society in the investigation of the Chapman Method for Determining Consistency.

Your committee has also, upon invitation of the Executive Committee, appointed the following special sub-committee to cooperate with the sub-committees representing other committees of the Society interested in the matter of a Standard Screen Scale:

S. S. Voorhees, *Chairman;* C. W. Boynton; Col. Chester Harding; Wm. K. Hatt; J. H. Holst; Spencer B. Newberry; Clifford Richardson.

Your committee believes, however, that this question covers a much greater field than that in which the Society is interested and suggests that the Society invite other societies interested to consider this question through the organization of a Joint Committee.

This report has been submitted to letter ballot of the committee, which consists of 44 members, of whom 38 have voted affirmatively, none negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

GEORGE F. SWAIN,
Chairman.

RICHARD L. HUMPHREY,
Secretary.

APPENDIX I.

REGULATIONS GOVERNING COMMITTEE C-1.

NOTE.—These regulations are supplementary to the "Regulations Governing Technical Committees."

ARTICLE I.

OFFICERS AND THEIR ELECTION.

SECTION 1. The officers of Committee C-1 shall be the Chairman, two Vice-Chairmen and a Secretary, all of whom, except one Vice-Chairman, shall represent non-producing interests.

SEC. 2. The terms of office shall be for two years; and officers shall be eligible for re-election.

ARTICLE II.

DUTIES OF OFFICERS.

SECTION 1. The Executive Direction of the Committee shall be vested in an Advisory Committee which shall consist of the officers of the Committee and the chairmen of its various sub-committees.

SEC. 2. Sub-committees proposed by the Committee shall be appointed by the Advisory Committee, subject to final ratification by the Committee.

SEC. 3. The Chairman shall preside at all meetings of the Committee and be an *ex-officio* member of all sub-committees.

SEC. 4. In the absence of the Chairman, the Vice-Chairmen in the order of their seniority, shall perform all the duties of the Chairman.

SEC. 5. The Secretary shall attend all meetings of the Committee and keep the minutes thereof. He shall conduct the correspondence and receive all communications addressed to the Committee. He shall issue notices of all meetings and promptly inform sub-committees of their appointment and

duties. He shall keep a complete list of members with their addresses, and a memorandum of the expenses of the Committee, and shall perform such other duties as may be imposed upon him.

ARTICLE III.

MEETINGS.

SECTION 1. Regular meetings of the Committee shall be held in the months of October, January, April and during the Annual Meeting of the Society, prior to the presentation of the annual report of the Committee, the time and place to be fixed by the Chairman.

SEC. 2. Special meetings may be called at the option of the Chairman or at the request of at least five members.

SEC. 3. Five members shall constitute a quorum.

SEC. 4. The Secretary shall keep a roll of the members of the Committee and shall record at each meeting the members in attendance. If a member or his authorized representative is absent from two consecutive meetings, without notice to the Secretary assigning reasons for the same, the Secretary shall notify the member that unless he advises that he wishes to continue as a member of the Committee with assurance that he will in the future be in a position to take an active interest in the work of the Committee and attend its meetings, his name will be dropped from the roll of membership. Such notices shall be sent out by the Secretary only on approval of the Chairman of the Committee.

ARTICLE IV.

AMENDMENTS.

SECTION 1. All amendments shall be adopted by letter ballot.

REPORT OF COMMITTEE C-3

ON

STANDARD SPECIFICATIONS FOR BRICK.

At the last annual meeting Committee C-3 submitted to the Society a report consisting of two parts; one on building brick and the other on paving brick. Both parts contained proposed specifications for the respective materials, but the committee did not feel that its information on building brick was sufficiently complete to enable it to present specifications for adoption by the Society.

In the case of building brick a new classification founded on compressive strength and absorption was proposed. The committee wished to test the feasibility of this classification by practical application throughout the country, and at the same time collect additional information from the principal brick-producing centers upon the relation between compressive strength, cross-bending strength, absorption and freezing. A special sub-committee was designated to arrange with the various testing laboratories for the testing of samples of brick produced in their own region, according to methods outlined by the committee in its last annual report. It was decided to solicit the cooperation of the engineering laboratories of the various universities and technical schools. Their assistance would produce a two-fold result, namely, secure the accurate information which the committee desired upon a wide range of material, and stimulate an interest in the universities and technical schools in the study and accurate testing of brick. In the development of this idea letters were sent to the deans of the laboratories asking if they would cooperate with the work to the extent of making tests, provided the samples could be delivered to them without cost. All laboratories except one signified their willingness, often with enthusiasm.

The exception is an institution of high standing, which has already made an exhaustive study of the brick of its surrounding region and considered further work duplication. A copy of the report of its investigation was furnished the committee.

The institutions cooperating in the investigation are as follows:

State.	Institution.	In Charge of Tests.
Alabama	University of Alabama	Edgar B. Kay.
California	University of California	C. Derleth, Jr.
Colorado	University of Colorado	Milo S. Ketchum.
Florida	University of Florida	J. R. Benton.
Illinois	University of Illinois	A. N. Talbot.
Indiana	Purdue University	Wm. K. Hatt.
Iowa	Iowa State College	A. Marston.
Kansas	University of Kansas	H. A. Rice.
Louisiana	Tulane University	W. B. Gregory.
Maine	University of Maine	Harold S. Boardman.
Massachusetts	Massachusetts Institute of Technology	Chas. M. Spofford.
Michigan	University of Michigan	Henry E. Riggs.
Missouri	Municipal Testing Laboratory, City of St. Louis	Mont Schuyler.
Missouri	University of Missouri	F. P. Spalding.
Nebraska	University of Nebraska	Geo. R. Catburn.
New York	Columbia University	Wm. H. Burr.
New York	Rensselaer Polytechnic Institute	T. R. Lawson.
New York	Cornell University	E. E. Haskell.
Pennsylvania	University of Pittsburgh	J. Hammond Smith.
Pennsylvania	University of Pennsylvania	Edgar Marburg.
Tennessee	Vanderbilt University	W. H. Schuerman.
Washington	University of Washington	Almon H. Fuller.
West Virginia	University of West Virginia	C. R. Jones.
Wisconsin	University of Wisconsin	M. O. Withey.

The committee has had to depend upon the interest and generosity of the manufacturers in securing samples, and even had to request them to prepay the transportation and packing expenses since no funds were available to the committee for that purpose.

It was hoped that at least a portion of the results might be available to be reported to the Society at this meeting, but the time required to get the investigation under way was longer than anticipated.

All of the cooperating laboratories are being supplied with a standard laboratory record form prepared by the committee and printed by the Society (see Plate III). On the back of this form are printed full instructions as to the methods of making the

tests. As the reports are received they will be bound in a suitable manner and filed as permanent records of the Society.

The committee submitted last year proposed Standard Specifications for Paving Brick covering the method of sampling, construction of the rattler, methods of performing the rattler test, and certain descriptive matter concerning the interpretation to be put upon the tests. These specifications were published during the year and have been sent broadcast among the brick manufacturers and engineers who are interested in the use of paving materials.

During the past year, the use of the method of testing prescribed in the specifications has continued to gain use. Up to this time no criticism of the specifications proposed by the subcommittee on paving brick has been received. An effort to secure the cooperation of the American Society of Municipal Improvement in the way of a joint committee to discuss this phase of the work was unsuccessful, owing to the unwillingness of their delegates to bear the expenses of attending such a meeting. It is known, however, that some members of their committee do not favor the specifications proposed.

The committee expects to recommend at the annual meeting in 1915 that the proposed Standard Specifications for Paving Brick be submitted to letter ballot of the Society.

This report has been submitted to letter ballot of the committee, which consists of 14 members, of whom 8 have voted affirmatively, none negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

A. V. BLEININGER,
Chairman.

D. E. DOUTY,
Secretary.

[NOTE.—For further report by Committee C-3 relative to specifications for paving brick, see Discussion on following page.—ED.]

COOPERATIVE INVESTIGATION.

AMERICAN SOCIETY FOR TESTING MATERIAL

COMMITTEE C-3

AND

THE ENGINEERING LABORATORY OF.....

LABORATORY RECORD.

Brick received from.....

Address.....

Sampled by..... Date.....

Type..... Class (A. S. T. M.)....

ABSORPTION TEST.

Sample No.	Weight.			Absorptio
	Dry (a)	Saturated (b)	Difference ($b-a$)	$\frac{b-a}{a}$
1				
2				
3				
4				
5				
Sum.....				
Average....				

COMPRESSION TEST.

Sample No.	Dimensions of half brick.			Load
	Width (w), in.	Length (l) in.	Area (a) $a=wl$	At first crack, lb.
1				
2				
3				
4				
5				
Sum.....				
Average....				

TRANSVERSE TEST.

Sample No.	Dimensions.			Load (W), lb.	M
	Width (b), in.	Depth (d), in.	Span (l), in.		
1					
2					
3					

4					
5					
Sum					
Average					

SUMMARY.

Average Absorption, per cent.	Average Compressive Strength, lb. per sq. in.	

Observers:

_____

_____

DISCUSSION.

Mr. A. V. Bleininger (*Chairman of Committee C-3*).—At a meeting of Committee C-3, held July 1, 1914, at which nine of the fourteen members of the committee were present, the following amendments to the proposed paving brick specifications, as submitted last year in the report of the committee, were adopted by an eight-to-one affirmative vote (the page numbers referred to are those of Volume XIII of the Proceedings): Mr. Bleininger.

Section 7, page 292, line 31, omit the words "but no liner shall be replaced by a new one except as the whole set is changed."

Section 7, page 292, line 35, beginning "When a new set of liners has been placed in position, etc.," change to read: "When a new rattler, in which a complete set of new staves is furnished, is first put into operation, it shall be charged, etc."

Section 7, page 293, line 3, paragraph beginning "No set of liners, etc.," change to read:

"No stave shall be used for more than 70 consecutive tests without renewing its lining. Two of the 14 staves shall be removed and relined at a time in such a way that of each pair, one falls upon one side of the barrel and the other upon the opposite side, and also so that the staves changed shall be consecutive but not contiguous; for example, 1 and 8, 3 and 10, 5 and 12, 7 and 14, 2 and 9, 4 and 11, 6 and 13, etc., to the end that the interior of the barrel at all times shall present the same relative condition of repair. The changes in the staves should be made at the time when the shot charges are being corrected, and the record must show the number of charges run since the last pair of newly lined staves was placed in position."

Section 8, page 293, line 23, sentence beginning "It shall be belt driven, and the pulley, etc.," change to read: "If a belt drive is used, the pulley, etc."

Section 8, page 293, line 25, sentence beginning "A belt of 6-in. double strength leather, properly adjusted, to avoid,

Mr. Bleininger. etc.," change to read: "A belt at least 6 in. in width, properly adjusted to avoid, etc."

Page 296, add to item 14 the words "and last renewals of stave liners"; and omit items 15 and 16 and renumber the remaining items.

Page 297, in table headed "Standardization Data," provide new column for recording the renewal of freshly lined staves and their position on the rattler. Omit the second and third lines following this table, reading "Number of charges tested since stave linings were renewed," and "Number of revolutions run upon stave linings before first test was run."

Section 20, page 299, line 23, insert the word "substantially" before the word "intact."

Mr. Blanchard. MR. A. H. BLANCHARD.—I move that the report which it is proposed to present to letter ballot in 1915 be referred to Committee D-4 on Standard Tests for Road Materials.

The Chairman. THE CHAIRMAN (MR. W. K. HATT).—Perhaps it would be better to change that motion, if agreeable, so that this matter be referred to the Executive Committee.

Mr. Blanchard. MR. BLANCHARD.—Two provisional methods were proposed by Committee D-4 relative to making mechanical analyses of broken stone and broken stone and sand. These methods were of particular interest to those using sand and products of rock crushers in the construction of various types of roads and pavements. These methods have been referred to another committee because the members of this committee were likewise interested in the methods of making mechanical analyses of these products from the standpoint of their utilization in cement concrete. It was evidently felt, judging from the action previously taken at this session, that the committees should have the privilege of discussing the matter at a joint conference rather than upon the floor of the convention. Thus a precedent has been established relative to action on a report, the subject matter of which relates to fields covered by two or more committees.

Committee D-4 consists of thirty-three members, including many highway engineers who are using paving brick and appreciate the intimate relationship between the physical properties of paving brick which are covered by tests and its use in construction. Many of these engineers have very definite opinions

relative to the methods of making tests of paving brick and the interpretation of the results of such tests. It is in order to save time, as expressed by previous speakers in discussing the submission of the report of Committee D-4 to other committees, and in view of the precedent established at this session, that I would advise the discussion of the report on paving brick at a conference of the interested committees prior to its coming before the Society. Mr. Blanchard.

THE SECRETARY.—I think a little consideration will make it clear that this case is not identical with, nor even closely analogous to the other case cited by Mr. Blanchard. In this instance we have a committee which is specifically designated Committee C-3 on Standard Specifications for Brick. If that committee is not of a sufficiently representative character, and if it is desirable that its personnel should be enlarged, a suggestion to that effect directed first to the committee itself, and, if need be, afterwards to the Executive Committee, would seem to meet that situation. But there is no telling where we shall land if a committee that is appointed for the sole purpose of preparing specifications for a certain product, should have to have its reports reviewed by another committee more or less directly concerned with that product. The Secretary.

MR. W. A. AIKEN.—I agree with the Secretary that the conditions in this case are entirely different from those in the previous case. We might as well say that the specifications of Committee A-1 on Steel shall be submitted for review to Committee C-2 on Reinforced Concrete, because they are interested in reinforcing bars. Mr. Aiken.

THE CHAIRMAN.—The Chair is in doubt about the order of this entire discussion and does not know whether this body has power to order the reference of this report to some other committee. It seems that that is a function of the Executive Committee, and that the motion should be to refer to the Executive Committee for reference to the proper committees concerned, or else that the suggestion of the Secretary should be followed. The Chairman.

MR. BLEININGER.—In regard to this matter, I wish to say that these specifications are based upon the work of several years, and I think the question of referring this work back to another Mr. Bleininger.

Mr. Bleininger. committee which has done no work whatever on this subject is utterly wrong. This work has cost thousands of dollars contributed by many interests, by The National Paving Brick Manufacturer's Association, by persons who have no financial interest in the subject whatever, by government institutions and universities. I believe that this work has a right to stand upon its own feet without any reference to a committee whose work may have more or less bearing upon this subject. I protest against the proposed action. Attention is called to the fact that these specifications cover only the method of testing, and do not attempt to dictate to the highway engineer what shall be the abrasion loss of paving brick under any and all conditions.

Mr. Blair. MR. W. P. BLAIR.—I don't understand the purpose of the motion. To my mind, it is a very strange proposition. The question of specifications for paving brick has been before the Society for a number of years, and the committee has not had, so far as my knowledge goes, one single suggestion from other sources, even from the committee to which it is now proposed to refer this question. I certainly protest against the motion, and against the intimation that it seems to involve. As Mr. Bleininger has said, thousands of dollars have been spent on this work and it has been pursued most faithfully in order to determine the results that are contained in this report.

Mr. Randall. MR. T. A. RANDALL.—I wish to concur in the remarks of Mr. Bleininger and Mr. Blair. I know what the committee has been doing for several years. It seems to me that all of that work will have been done for nothing if such a resolution should pass.

The Chairman. THE CHAIRMAN.—If there is no further discussion I shall call for a vote on Mr. Blanchard's motion that this report be referred to Committee D-4 for consideration.

Mr. Blanchard. MR. BLANCHARD.—In conference with Committee C-3.

The Chairman. THE CHAIRMAN.—In conference with Committee C-3, by whom this report was presented.

[The motion was lost.]

REPORT OF COMMITTEE C-4

ON

STANDARD SPECIFICATIONS AND TESTS FOR CLAY AND CEMENT SEWER PIPES.

The committee begs to submit the following progress report:

At the time of the last annual meeting, the committee had completed and presented a complete schedule of the analytical data requiring consideration in establishing the demands and properties of sewer pipes and for the mill, field and laboratory tests; heretofore referred to as Classes I and II. This schedule had been divided into appropriate heads and referred to various sub-committees for discussion and presentation of complete data. There had also been prepared and submitted to the committee a glossary of terms to be used in its report.

During the past year, reports of the sub-committees covering certain portions of the analytical data have been in progress, and several reports have been presented to the committee.

The committee has prepared and approved memoranda of recommendations for laying sewer pipes, heretofore referred to as Class III, which are presented herewith as a preliminary report (Appendix I), to serve as a guide in the preparation of the final report.

The glossary of terms has been presented to and approved by the full committee, and is presented herewith as a preliminary report (Appendix II).

The officers of the committee have held seven meetings during the past year, and it is intended to hold at least one meeting during the convention for discussions by all the members of the committee who are able to attend.

This report has been submitted to letter ballot of the committee which consists of 20 members, of whom 12 have voted affirmatively, 1 negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

RUDOLPH HERING,
Chairman.

E. J. FORT,
Secretary.

A. J. PROVOST,
Vice-Chairman.

APPENDIX I.

MEMORANDA OF RECOMMENDATIONS FOR THE LAYING OF SEWER PIPE.

In order to intelligently discuss the "Demands Made Upon Sewer Pipes" it has appeared to the committee that it would be helpful and advisable to precede the discussion by a statement of the practical conditions under which sewer pipes are laid and upon which conditions the demands made upon them must to a large extent depend.

These practical conditions are those which will affect the strength of the pipes in their resistance to the external stresses.

I. Preparing Trenches and Foundations for Pipe Laying.

The foundations in the trench should be formed to prevent any subsequent settlement and thereby a rupture of the pipes. If the natural foundation is rock it is recommended that an equalizing sand bed be placed upon the rock and well compacted by watering or otherwise so as to obviate irregular settlement. If the natural foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of the pipe. Otherwise the bed should be made firm, either by sand well watered or rammed, or by a layer of cement mortar. The same means of securing a firm foundation should be adopted in case the excavation has been made slightly deeper than necessary.

If there is no good natural foundation, a firm and sufficiently broad bed should be artificially made either with sand, with gravel or broken stone, with concrete, reinforced concrete or other means to secure a solid and firm foundation.

If the soil is porous and ground water rises above the sewer pipe, a plank foundation with or without piles may be required.

When the sewer is to be laid in a concrete cradle, the concrete for the full width of the cradle should be continuously deposited

to the height of the outside bottom of the pipe. Before the concrete has set the pipe shall be evenly bedded therein and the remainder of the concrete immediately placed on each side of the pipe and carefully tamped in such a manner as to avoid disturbing its position. Or, the pipe may be supported and held in position by wedges or templates and the concrete mixed wet, and poured under and around it in such a manner as to complete the cradle in one operation.

When the sewer is to be laid in a gravel or broken-stone cradle, the material should consist of clean gravel or sound broken stone, all of which should preferably pass through a screen of 1-in. mesh and be retained on one of $\frac{1}{8}$-in. mesh. The gravel or broken stone should be deposited and consolidated for the full width of the trench to the height of the outside bottom of the pipe. The pipe should then be bedded therein and the remainder of the gravel or broken stone deposited and carefully consolidated in such a manner as to avoid disturbing the position of the pipe. The cradles should in all cases be so constructed that an undue proportion of the load shall not be borne by the hubs.

If the trench is situated in ground water, it is recommended to lay the pipe in a concrete cradle up to the springing line.

When a sewer is to be laid without a cradle the earth forming the bed should be carefully freed from stones and organic material. The pipe should then be evenly bedded therein, the joints properly made and the backfilling placed and firmly tamped in such a manner as to avoid disturbing the position of the pipe.

When pipe is laid in soil which is not sufficiently firm to carry it, the earth or soil should be removed, and sufficiently broad foundations and retaining supports substituted.

When pipe is to be laid in new embankment the fill up to a point over the springing line of the pipe should be deposited in layers not exceeding 6 in. and thoroughly consolidated by rolling, ramming, teaming, watering or a combination of these, depending upon the nature of the filling material, whether it is clay, sand, gravel or a mixture of these.

If a pipe line is situated on one side of an embankment where the soil is liable to lateral movements, and is thus subjected to a one-sided load or pressure, care must be taken to secure a staple foundation, so that the pipe line will not be moved on its

bed. A retaining support should be placed at the side having the less pressure. It should be made of suitable material, of proper height, width and weight, to transfer to the foundation the excessive lateral earth pressure, without danger to the stability of the pipe line.

Trenches should be kept free from water until the material in the pipe joints has hardened sufficiently so that the pipe line will be continuous and strong.

The stresses produced in pipe by the backfilling will differ according to the conditions of the soil. In self-sustaining soil it is possible to lay pipe at a considerable depth without producing excessive stresses. In soil which permits of lateral movement or which is water-carrying, special precautions are necessary.

To protect pipe lines from unusual stresses all work should be done in open trenches. Tunneling should be prohibited except with the special consent of the engineer.

Pipe lines should be placed at such a depth below the surface of the street that dangerous pressure or impact cannot occur. If it is not possible to do this, special reinforcement is required.

Rock excavation should be made to a depth of at least 4 in. below the outside bottom of the pipe, or as shown on the plan.

Width of trenches in earth should be sufficient to provide a free working space of from 6 to 12 in., exclusive of spurs and hubs, according to the size of the pipe and the character of the ground.

The width of trenches in rock should be sufficient to provide a free working space of 12 in. on each side of the pipe exclusive of spurs and hubs.

In every case there should be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly ram the backfilling around the pipe and to secure tight joints.

If soil conditions and ground water require the use of sheeting, sheet piling and bracing, the trenches should be made correspondingly wider. The sheeting should be closely driven and to such depths as the soil conditions may indicate.

Steel sheeting may be used with advantage where the flow of ground water into the trenches is excessive and the stability of the foundation soil and of the sewer is affected thereby.

Where a trench for a proposed sewer or extension of a sewer

terminates in rock, it should be excavated for a distance of not less than 5 ft. beyond the end of the sewer and in the direction of the proposed extension. The pipes and all other structures should be carefully protected from the effects of blasts.

II. Pipe Laying.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot end points in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert. Unless otherwise permitted or directed, not less than 20 ft. of pipe sewer should be laid in one operation.

It is necessary to use all possible care when shoving the pipes together, so that mortar will not be shoved into the hub or the joint be unnecessarily large.

Sockets should be carefully cleaned before pipes are lowered into trenches. The pipe should be so lowered as to avoid unnecessary handling in the trench. After the ends of the pipes have been sufficiently wetted, the hub end should receive upon its lower half a layer of mortar composed of one part of Portland cement to one or two parts of fine sand.

The pipe should be set firmly according to line and grade, and the joint carefully adjusted, filled with mortar and finished to a smooth bevel outside. The inside of the pipes should be then cleaned of dirt and mortar refuse. In small pipes the inside should be made smooth by a hand swab. Large pipes should be laid with block and tackle and bar and tongs.

Gasket and mortar joints should be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than $\frac{3}{4}$ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular space between the pipes with a suitable caulking tool. Before being placed, the gasket should be saturated with neat cement grout. The remainder of the space should then be completely filled with plastic mortar mixed 1:1, and the joint wiped inside and finished to a smooth bevel outside.

Where butt or bevel joint pipes are used, the following method of joining is recommended: After a layer of mortar about 8 in. wide has been prepared at the joints, a wire netting is spread upon the same and covered with a layer of mortar about an inch thick. Upon this wire netting, which is embedded in the mortar, forming a bandage, the pipes are laid and adjusted according to line and grade. The bandage is then raised on both sides of the pipe, bound at the top, and covered with a layer of strong cement mortar at least 2 in. thick. The inside of the joint is finished in the same manner as specified for hub-and-spigot pipes.

The ends of pipes which enter masonry should be neatly cut to fit the face of the masonry.

No pipe or the cradle thereof should be laid or placed until the sub-grade of the trench has been tested and found correct.

In deep cuts, in high embankments or in poor soil, it is recommended to use especially strong pipes or concrete reinforcement.

The smaller sizes of cement or concrete pipes should preferably have flat bases. If of sufficiently large diameter, they may be reinforced.

When mortar or concrete are to be mixed or placed in freezing weather the following precautions are advised: No concrete should be laid when the temperature of the air is below 24° F. When the temperature is between 24 and 32° F., and rising, the mixing water should be heated to a suitable temperature, or, if directed, one per cent of salt, by weight, should be added for each degree of Fahrenheit of air temperature below 32° F. Under such conditions other materials for concrete and mortar should all be heated.

III. BACKFILLING TRENCHES.

All trenches and excavations should be backfilled immediately after the pipes are laid therein, unless otherwise directed. The backfilling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be used up to a level at least 2 ft. above the top of the pipe. This material should be carefully deposited in uniform layers about 6 in. in depth. Unless otherwise per-

mitted, each layer should be carefully and solidly tamped or rammed with proper tools, so as not to injure or disturb the pipe line. The backfilling material for the remainder of the trenches should contain no stones over 10 in. in their largest dimensions, should be spread in layers and thoroughly consolidated by tamping or otherwise as the engineer might direct. Stones which are used in backfilling should be so deposited through the mass that all interstices are filled with fine material.

Where the safety and stability of the pipe line and other structures render it necessary, sheeting should be left in place, particularly below the top of the pipe.

Where sheeting is withdrawn, all cavities remaining or adjoining the trench should be solidly filled. When the sheeting is left in place, all cavities behind such sheeting should be solidly filled.

For retaining backfilling temporarily, timber bulkheads may be used. They should be removed as the trenches are backfilled.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravelly materials. If this method is used, then the first flooding should be applied after the backfilling has been compacted by tamping up to the springing line of the pipe, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipe, and also to prevent an undue excess of pressure on the pipe.

Walking or working on the completed sewer, except as may be necessary in tamping or backfilling, should not be permitted until the trench has been backfilled to a height of at least 2 ft. over the top of the pipe.

Where a one-sided pressure exists, due to unbalanced loading, the filling of the trench should be carried on simultaneously on both sides and in such a manner that injurious side pressures do not occur.

In freezing weather backfilling should not contain any frozen lumps of earth below a level at least 2 ft. above the top of the pipe.

APPENDIX II.

GLOSSARY OF TERMS.

I. Forces Acting upon Sewer Pipe.

External Forces.—Forces resulting from pressures or impact acting from the outside upon the pipe.

Internal Forces.—Forces resulting from interior fluid pressure.

Abrasion.—Wearing away of surface material by friction.

II. Raw Materials.

Physical Properties.—Those sensible properties of raw materials, which in their combinations affect the manufacture and use of the product.

Chemical Properties.—Those properties resulting from combinations of elements in the raw materials, which in their composition affect the manufacture and use of the product.

III. Pipe.

(*a*) *Sewer Pipe.*—Separate pipe suitable for the conveyance of domestic and industrial sewage and storm water and capable of being properly joined to form a conduit.

Clay Pipe.—Made from red burning plastic clay devoid of fissile structure. Maturing temperature about 1170° C. Vitrification not ordinarily produced, and salt glazing not always effective.

Fire-Clay Pipe.—Made from buff, gray or reddish burning fire clay showing conchoidal structure. Maturing temperature about 1250° C. Complete stony vitrification may be produced, but an absorption lower than 3 per cent is not general, nor desirable for maximum strength.

Shale Pipe.—Made from red burning hard clay with a distinct fissile structure. Vitrification at from 1050 to 1250° C., and salt glazing successful only at highest temperature.

Cement-Concrete Pipe.—Pipe formed by consolidating in a mold a mixture of Portland cement, water, sand, stone or other hard material, and permitting it to harden by natural process prior to handling and use.

Special.—A pipe other than a straight pipe.

Branch.—A pipe attached to and diverging from the barrel of another pipe, such as Y-branches, T-branches, etc.

(*b*) *Demands upon Sewer Pipes.*—Requirements of qualities which are desirable and attainable under conditions of actual practice.

IV. Parts of Sewer Pipe.

Barrel or Shell.—Main body of a pipe, exclusive of differently formed ends.

Ends.—Those parts of a pipe which terminate it and are so formed as to permit of making a proper joint.

Beveled End.—End surfaces of pipes inclined at an angle with the pipe axis so formed that the end of one pipe can enter the end of the adjoining pipe with a close fit.

Hub or Bell.—That end of a pipe which is sufficiently enlarged for a short distance to receive and enclose the spigot end of the adjoining pipe, to form a joint.

Spigot.—That end of a pipe which enters and is formed to fit the hub or bell of the adjoining pipe; it is sometimes scored or has a head.

Butt.—Plain end of a pipe sometimes scored on the outside, to close up against a similar end of an adjoining pipe for the purpose of forming a joint, the two ends being surrounded and covered by a collar.

Collar.—A flat band to surround and cover a butt joint.

Base, form of.—Shape of that part of a pipe which rests upon a foundation.

V. Joints.

Beveled.—Formed by joining pipes with beveled ends and applying the jointing material.

Hub and Spigot.—Formed by inserting the spigot end of one pipe into the hub of another and applying the jointing material.

Butt and Collar.—Formed by abutting the butt ends of two adjacent pipes and, after applying the jointing material, surrounding the joint with a collar.

Jointing Materials.—The materials which are inserted between the ends of adjoining pipes for the purpose of forming a continuous closed conduit.

Elasticity of Joints.—Ability of jointed pipes to resist strains caused by bending and returning to original position.

VI. FINISHED PRODUCT.

(*a*) *Material.*

Durability.—Resistance to disintegration or deterioration.

Serviceability.—Ability to readily and effectively render satisfactory service.

Thickness.—Distance between outside and inside surfaces.

Strength.—Ability to resist physical forces imposed during handling and after pipe has been put in use.

Toughness.—Relative degree of resistance to impact without fracture as opposed to brittleness.

Hardness.—Intensity of molecular cohesion as measured by resistance to penetration by a standard tool.

Smoothness.—Evenness of surface without projections or irregularities.

Vitrification. Fusion into a hard glassy material under high heat.

Shrinkage.—Diminution of dimensions and mass of the material.

Porosity.—Ratio of the volume of interstices of the material to the volume of its mass.

Percolation.—Passage of water through the interstices of the material.

(*b*) *Covering.*

Coating.—A covering of other materials applied in liquid form.

Glazing.—Hard glassy surface covering.

Salt Glazing.—Glazing produced by application of salt during vitrification.

Lining.—A covering of other material applied in solid form to inside surfaces.

Waterproofing.—Materials resistant to penetration by water.

(c) *Defects.*

Warp.—Twisted out of normal shape.

Fracture.—Rupture of the material by a break through its entire thickness.

Crack.—Fissure or open seam not necessarily extending through body of material.

Fire Crack.—A crack resulting from lack of uniformity in shrinkage after the application of excessive heat.

Hair Crack.—Irregularly running, fine, narrow crevice or fissure at the surface of a pipe not penetrating deeply, and caused by a shrinkage of material during manufacture.

Blister.—Convex hollow prominence formed by separation and raising of a film in the process of burning.

Leakage.—Passage of water contrary to intention.

Lamination.—Division of material into thin layers or sheets.

VII. Identification.

Marking and Imprints.—Impressions made upon pipe at the place and time of manufacture for the purpose of identification.

REPORT OF COMMITTEE C-5

ON

FIREPROOFING MATERIALS.

Committee C-5 has held one meeting during the year at which an outline for a standard test for fire-resistive coverings for columns was discussed. The committee had no definite data on which a specification for such a test could be based. An outline of what should constitute the test was prepared, but it was felt that no recommendation should be made as yet.

The Underwriters' Laboratories of Chicago are now erecting a test structure in cooperation with the Factory Mutual Fire Insurance Companies, who have contributed to the expense, and have outlined a series of tests. The heavy foundations and frame work of the testing apparatus have been erected, but it will probably be some months before the apparatus and furnace are completed and in shape for actual tests.

Mr. J. R. Freeman, of this committee, has recently inspected the structure and finds that it promises excellent results, and that delay is due to the enlarged capacity and scope. It will be the most wonderful machine of the kind ever built and has been designed for a wide range of tests and accurate control of temperatures. The aid of the United States Bureau of Standards is being enlisted for temperature measurements and general cooperation.

There is a special demand for a series of tests of heat-retardent coverings of moderate cost for columns and girders of isolated factories, which, while not of the highest standard of efficiency, could still be relied upon to give ample time for escape of operatives and for bringing fire-extinguishing apparatus into use. Considerable material for these tests has been already secured.

Until the actual testing has at least been started, the committee thinks it unwise to outline a test that may have to be modified when more experience has been had.

This report has been submitted to letter ballot of the committee, which consists of 9 members, of whom 8 have voted affirmatively, none negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

I. H. Woolson,
Chairman.

R. P. Miller,
Secretary.

REPORT OF COMMITTEE C-6

ON

STANDARD TESTS AND SPECIFICATIONS FOR DRAIN TILE.

In its annual report[1] for 1913, Committee C-6 expressed the hope that it would be able to present definite specifications for drain tile to the Society at the 1914 meeting, for consideration and possible adoption. This hope has been fulfilled, and Committee C-6 hereby recommends the following for adoption:

Proposed Standard Specifications for Strength Tests of Drain Tile;

Proposed Standard Specifications for Quality of Drain Tile;

Proposed Recommended Practice in Design and Construction of Tile Drains.

These specifications and recommended practice were found to be so interrelated as to require simultaneous development. No satisfactory and definite specifications for quality of tile could be decided upon until standard specifications for strength tests had also been decided; and the strength of drain tile in ditches is so dependent on the details of the pipe laying, as to require the formulation of recommended practice in tile-drain design and construction (as related to stability), in order that strength requirements might be made definite and intelligible.

Committee C-6 has held four meetings since the date of its last annual report in June, 1913: At Ames, Iowa, October 15, 1913, with an attendance of 12 out of a total of 16 members, present in person or represented by duly authorized proxy; at Jefferson, Iowa, October 18, 1913, with an attendance of 12; at Chicago, Ill., March 18, 1914, with an attendance of 14; at Chicago, Ill., April 20, 1914, with an attendance of 10. A number

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 303 (1913).

of representatives of important tile manufacturing interests were present as visitors at each of these meetings, except the last one.

The meetings at Ames, Iowa, and Jefferson, Iowa, were held to inaugurate actual tests, under the personal direction of the committee members, of 600 clay and concrete tile by three kinds of bearings. The tile were of 8, 16, and 24 in. in diameter. The clay tile had been supplied free of charge at Ames, Iowa, by the International Clay Products Bureau, of Kansas City, Mo. The concrete tile had been manufactured at the expense of the Iowa Engineering Experiment Station, at the factory of Mr. A. S. Tanner, Jefferson, Iowa, which was selected by the representatives of the concrete-tile manufacturing industry.

The Iowa Engineering Experiment Station, with some assistance and supervision by representatives of committee members, completed, calculated, tabulated and reported the special tests for Committee C-6 thus inaugurated. The report was distributed to the committee members at the end of February, 1914, and consisted of 53 blue-print tables and diagrams, accompanied by explanatory printograph text, all bound in pamphlet form.

At the meeting in Chicago March 18, 1914, the detailed results of the investigations of the committee were fully discussed. It was decided that the results showed that it would be both advisable and feasible to permit in the proposed Standard Specifications for Strength Tests of Drain Tile the use of all three of the bearings investigated; namely, sand bearings, hydraulic bearings, and three-point bearings. It was decided that results of strength tests by these three bearings have quite definite ratios to each other, and that all give reliable indications of the strength of the tile tested. At this same meeting the most important general principles of the proposed Standard Specifications for Quality of Drain Tile and the proposed Recommended Practice in Design and Construction of Tile Drains were also determined, and three sub-committees, of three members each, were appointed to finish detailed drafts of the three sets of proposed standard specifications.

The three sub-committees took up their work immediately after the meeting of March 18, and the three chairmen and one other member held a joint meeting at Madison, Wis., March 31,

1914. Typewritten copies of each of the specifications and recommended practice drafted were sent by the respective chairmen in due time to each member of Committee C-6.

At the meeting of Committee C-6 in Chicago, April 20, 1914, these drafts were thoroughly revised, clause by clause, and after adoption were sent to letter ballot of the committee, with the following results:

	Affirmative.	Negative.	Not Voting.
STRENGTH TESTS OF DRAIN TILE.			
Sections 1–10 inclusive	13[a]	0	1
Section 11	12	1[a]	1
Section 12	13[a]	0	1
QUALITY OF DRAIN TILE.			
All sections	3	0	1
RECOMMENDED PRACTICE IN DESIGN AND CONSTRUCTION OF TILE DRAINS.			
All sections	13[b]	0	1

[a] In the case of 2 votes for Section 3, 1 vote for Section 7, 1 vote against Section 11, and 1 vote for Section 12, a slightly different specification was preferred.

[b] In the case of 1 vote each for Sections 2, 3, 4 and 6, a slightly different specification was preferred.

At the meeting of April 20 the committee also determined, in accordance with previous correspondence between its chairman and Secretary-Treasurer Marburg, to publish the detailed report of its investigations and conclusions in the form of a bulletin, provided the approval of the Executive Committee could be secured. Such publication was made possible by the offer of the Iowa Engineering Experiment Station to bear the expense, provided the bulletin would appear as a joint bulletin of the committee and the station. It is estimated that the Iowa Engineering Experiment Station has spent at least $3000 in the special investigations of Committee C-6, in addition to its own extensive investigations along similar lines, the results of which were published as Bulletin No. 31 of the station, and which have also been available to Committee C-6.

The new publication will be Bulletin No. 36, of the Iowa Engineering Experiment Station series. It is confidently expected that it will be ready for distribution in time to permit

a copy to be placed in the hands of each member of the Society at the time of consideration of the annual report of Committee C-6.

Effort is being made to place in this bulletin all data and explanation needed to enable each engineer to judge and interpret for himself each section of the proposed standard specifications and recommended practice herewith recommended to the Society by Committee C-6 for adoption.

Committee C-6 reports further that considerable progress has already been made on a special experimental investigation of absorption, and freezing and thawing tests, and their relation to strength and durability, which the University of Wisconsin is generously making for the committee. Professor Withey, of that institution, is making the tests, which are being applied both to clay and to concrete tile, of different grades, materials and processes.

The completion of these investigations, the collating and study of their results, and the preparation of proposed standard specifications for absorption and other durability tests, and for corresponding requirements for quality of drain tile, to be inserted in their appropriate places in the proposed Standard Specifications for Strength Tests of Drain Tile and for Quality of Drain Tile, constitute the main part of the program for the work of Committee C-6 for 1914–15.

This report has been submitted to letter ballot of the committee, which consists of 14 members, of whom 11 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

A. Marston,
Chairman.

J. T. Stewart,
Secretary.

[Note.—For action taken on the above report, see pages 24-25. The report includes two proposed standard specifications, the one for strength tests and the other for quality of drain tile, and proposed recommended practice in design and

construction of tile drains. Since this report was presented, the committee has made certain changes in form and arrangement as distinguished from substance, by which the above matter has been incorporated in a single set of "Standard Specifications for Drain Tile." These specifications were adopted by letter ballot of the Society on September 10, 1914, and appear on pages 323–334 of the 1914 Year-Book.—ED.]

REPORT OF COMMITTEE C-7

ON

STANDARD SPECIFICATIONS FOR LIME.

Committee C-7 recommends that the proposed Standard Specifications for Quicklime and for Hydrated Lime, appended hereto, be referred to letter ballot of the Society.[1]

The committee has given careful thought to the suggestions contained in the discussion of the report and specifications submitted at the last annual meeting.[2] For reasons then stated the committee does not consider it advisable to incorporate in the appended proposed specifications for lime, tests for strength along the lines of those contained in the Standard Specifications for Cement.

This report has been submitted to letter ballot of the committee, which consists of 17 members, with the following results:

On the proposed Specifications for Quicklime: Affirmative, 11; negative, 3; not voting, 3.

On the proposed Specifications for Hydrated Lime: Affirmative, 12; negative, 2; not voting, 3.

Respectfully submitted on behalf of the committee,

J. S. MACGREGOR,
Chairman.

E. L. CONWELL,
Secretary.

[NOTE.—The proposed Standard Specifications for Quicklime and Hydrated Lime were not referred to letter ballot of the Society. For action taken on the above report, see Discussion on the report, page 220, or page 22.—ED.]

[1] The proposed specifications approved by the committee, but contain numerous changes which the committee recommends (see Discussion on the report, p. 220).—ED.

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 313 (1913).

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS FOR QUICKLIME.[1]

Definition. 1. Quicklime is a material the major part of which is calcium oxide or calcium and magnesium oxides, which will slake on the addition of water.

Grades. 2. Quicklime is divided into two grades:

(*a*) *Selected.*—Shall be a well-burned lime, picked free from ashes, core, clinker or other foreign material.

(*b*) *Run-of-Kiln.*—Shall be a well-burned lime without selection.

Forms. 3. Quicklime is shipped in two forms:

(*a*) *Lump Lime.*—Shall be the size in which it comes from the kiln.

(*b*) *Pulverized Lime.*—Shall be lump lime reduced in size to pass a $\frac{1}{4}$-in. screen.

Types. 4. Quicklimes are divided according to their chemical composition into four types:

(*a*) *High-Calcium.*—Shall be quicklime containing over 90 per cent of calcium oxide.

(*b*) *Calcium.*—Shall be quicklime containing not under 85 per cent and not over 90 per cent of calcium oxide.

(*c*) *Magnesian.*—Shall be quicklime containing between 10 and 25 per cent of magnesium oxide.

(*d*) *Dolomitic.*—Shall be quicklime containing not under 25 per cent of magnesium oxide.

[1] Criticisms of these Tentative Specifications are earnestly requested and should be directed, preferably before January 1, 1915, to Mr. E. L. Conwell, Secretary of Committee C–7, 2024 Arch Street, Philadelphia, Pa.

5. The particular grade, form and type shall be specified in advance by purchaser. **Basis of Purchase.**

I. CHEMICAL PROPERTIES AND TESTS.

(*A*) *Sampling.*

6. When quicklime is shipped in bulk, the sample shall be so taken that it will represent an average of all parts of the shipment from top to bottom, and shall not contain a disproportionate share of the top and bottom layers, which are most subject to changes. The samples shall comprise at least 10 shovelsful taken from different parts of the shipment. The total sample taken shall weigh at least 100 lb. and shall be crushed to pass a 1-in. ring, and quartered to provide a 15-lb. sample for the laboratory. **Lime in Bulk.**

7. When quicklime is shipped in barrels, at least 3 per cent of the number of barrels shall be sampled. They shall be taken from various parts of the shipment, dumped, mixed and sampled as specified in Section 6. **Lime in Barrels.**

8. All samples to be sent to the laboratory shall be immediately transferred to an air-tight container in which the unused portion shall be stored until the quicklime shall finally be accepted or rejected by the purchaser. **Laboratory Samples.**

(*B*) *Chemical Tests.*

9. (*a*) The grade, type and chemical properties of quicklime shall be determined by standard chemical methods of analysis. **Chemical Properties.**

(*b*) Selected quicklime shall contain not under 90 per cent of calcium and magnesium oxides and not over 3 per cent of carbon dioxide.

(*c*) Run-of-kiln quicklime shall contain not under 85 per cent of calcium and magnesium oxides, and not over 5 per cent of carbon dioxide.

II. PHYSICAL PROPERTIES AND TESTS.

10. An average 5-lb. sample shall be put into a box and slaked by an experienced operator with sufficient water to produce the maximum quantity of lime putty, care being taken **Percentage of Waste.**

to avoid "burning" or "drowning" the lime. It shall be allowed to stand for 24 hours and then washed through a 20-mesh sieve by a stream of water having a moderate pressure. No material shall be rubbed through the screens. Not over 3 per cent of the weight of the selected quicklime nor over 5 per cent of the weight of the run-of-kiln quicklime shall be retained on the sieve. The sample of lump lime taken for this test shall be broken to all pass a 1-in. screen and be retained on a $\frac{1}{4}$-in. screen. Pulverized lime shall be tested as received.

III. INSPECTION AND REJECTION.

Inspection.

11. (*a*) All quicklime shall be subject to inspection.

(*b*) The quicklime may be inspected either at the place of manufacture or the point of delivery as arranged at the time of purchase.

(*c*) The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the quicklime ordered. The manufacturer shall afford the inspector all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*d*) The purchaser may make the tests to govern the acceptance or rejection of the quicklime in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

12. Unless otherwise specified, any rejection based on failure to pass tests prescribed in these specifications shall be reported within five days from the taking of samples.

Rehearing.

13. Samples which represent rejected quicklime shall be preserved in air-tight containers for five days from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE SPECIFICATIONS FOR HYDRATED LIME.[1]

Definition. 1. Hydrated lime is a dry flocculent powder resulting from the hydration of quicklime.

Types. 2. Hydrated limes are commercially divided according to their chemical composition into four types:

(*a*) *High-Calcium.*—Shall be hydrated lime, the non-volatile portion of which contains over 90 per cent of calcium oxide.

(*b*) *Calcium.*—Shall be hydrated lime, the non-volatile portion of which contains not under 85 per cent and not over 90 per cent of calcium oxide.

(*c*) *Magnesian.*—Shall be hydrated lime, the non-volatile portion of which contains between 10 and 25 per cent of magnesium oxide.

(*d*) *Dolomitic.*—Shall be hydrated lime, the non-volatile portion of which contains not under 25 per cent of magnesium oxide.

Basis of Purchase. 3. The particular type of hydrated lime desired shall be specified in advance of purchase.

I. CHEMICAL PROPERTIES AND TESTS.

Sampling. 4. (*a*) The sample shall be a fair average of the shipment. Three per cent of the packages shall be sampled. The sample shall be taken from the surface to the center of the package. A 2-lb. sample to be sent to the laboratory shall immediately be

[1] Criticisms of these Tentative Specifications are earnestly requested and should be directed, preferably before January 1, 1915, to Mr. E. L. Conwell, Secretary of Committee C-7, 2024 Arch Street, Philadelphia, Pa.

transferred to an air-tight container, in which the unused portion shall be stored until the hydrated lime has been finally accepted or rejected by the purchaser.

(*b*) The non-volatile portion of hydrated lime shall contain not under 92 per cent of calcium and magnesium oxides.

(*c*) Hydrated lime shall contain not over 5 per cent of carbon dioxide and sufficient water to fully hydrate the calcium oxide present.

Chemical Properties.

5. The type and chemical properties of hydrated lime shall be determined by standard methods of chemical analysis.

II. PHYSICAL PROPERTIES AND TESTS.

Fineness.

6. A 100-g. sample shall leave by weight a residue of not over 5 per cent on a standard 100-mesh sieve and not over 0.5 per cent on a standard 30-mesh sieve.

Constancy of Volume.

7. A pat about 3 in. in diameter, $\frac{1}{2}$ in. thick at the center tapering to a thin edge, shall be made on a clean glass plate about 4 in. square, from a paste composed of equal parts by weight of hydrated lime and volume-constant Portland cement (gaged with only sufficient water to make the mixture workable). This pat, after hardening 24 hours in moist air, shall, when exposed in any convenient manner to steam above boiling water in a loosely closed vessel for 5 hours, show no signs of popping, checking, cracking, warping nor disintegrating.

III. PACKING AND MARKING.

Packing.

8. Hydrated lime shall be packed either in cloth bags containing 100 lb. or in paper bags containing 40 or 50 lb. and the weight shall be plainly marked on each package.

Marking.

9. The name of the manufacturer shall be legibly marked or tagged on each package.

IV. INSPECTION AND REJECTION.

Inspection.

10. (*a*) All hydrated lime shall be subject to inspection.

(*b*) The hydrated lime may be inspected either at the place of manufacture or the point of delivery, as arranged at the time of purchase.

(*c*) The inspector representing the purchaser shall have free entry at all times while work on the contract of the pur-

chaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the hydrated lime ordered. The manufacturer shall afford the inspector all reasonable facilities for inspection and sampling, which shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*d*) The purchaser may make the tests to govern the acceptance or rejection of the hydrated lime in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rejection.

11. Unless otherwise specified, any rejection based on failure to pass tests prescribed in these specifications shall be reported within five working days from the taking of samples.

Rehearing.

12. Samples which represent rejected hydrated lime shall be preserved for five days from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

DISCUSSION.

Mr. Macgregor.

MR. J. S. MACGREGOR (*Chairman of Committee C-7*).—At a meeting of Committee C-7, held at Atlantic City on July 1, at which 7 of the 17 members of the committee were present, it was decided to recommend numerous changes in these specifications, and to withdraw the recommendation that they be referred to letter ballot of the Society, but to recommend instead that they be printed for the present as tentative specifications.[1]

[On motion, it was decided that the specifications in their proposed revised form be printed for the ensuing year in the Proceedings and that their publication in the Year-Book be left to the judgment of the Executive Committee.]

[1] The tentative specifications here referred to appear in their revised form on pp. 214–219.—ED.

REPORT OF COMMITTEE D-1

ON

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

Committee D-1 now has 67 members and has held two meetings during the past year. At the meeting held November 14, 1913, 26 members were present, and at the meeting of April 17, 1914, 31 members were present.

The committee has adopted Regulations Governing Committee D-1, which are attached to this report as Appendix I.

In connection with the regulations governing the sampling of liquids, the secretary will furnish the necessary blank forms, labels, tags, seals, etc., to those procuring samples for any of the sub-committees.

It was decided that the committee should not take up the question of the preservation of wood by impregnation.

The following resolutions were passed at the meeting of April 17, 1914:

"*Resolved*, That Committee D-1 holds that as it entered into a contract with the paint manufacturers who furnished the paint for the Havre de Grace Bridge, that the paints would not be identified with the manufacturers' names, therefore, it is not authorized to furnish any information regarding these paints beyond that contained in the published reports of Committee D-1."

"*Resolved*, That this committee has no control over any statements made in regard to the published reports, and considers it inadvisable to comment on any such statements unless the statements are at variance with the facts stated in its reports."

Sub-Committee VII on Influence of Pigments on Corrosion has been discontinued, and a new sub-committee known as Sub-Committee XIII on Shellac has been established.

The committee has no standard specifications to present for letter ballot to the Society, but recommends the adoption of the Proposed Standard Definitions of Terms used in Paint Specifications, which were printed in the last report of Committee D-1,[1] and are appended to this report.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 403 (1913).

All of the sub-committees have been active during the past year and many of the reports appended show the results of much labor and thought. Those sub-committees which report only progress have not by any means been idle, but simply considered it better to defer publication until certain doubtful points have been cleared up by more work.

The reports of Sub-Committees II and IV, indicate that both the Havre de Grace Bridge and the Atlantic City Steel Plate Tests will soon become matters of history.

Sub-Committee I—the Advisory Committee—has held two meetings, but as it acts only when it is not advisable to call a meeting of the whole committee, it has no formal report to render.

Detail reports are appended from the following sub-committees:

Sub-Committee II on Inspection of Havre de Grace Bridge;

Sub-Committee III on Testing of Paint Vehicles;

Sub-Committee IV on Inspection of Steel Plates at Atlantic City;

Sub-Committee V on Linseed Oil;

Sub-Committee VIII on Methods of Analysis of Paint Materials;

Sub-Committee X on Inspection of White-Paint Test Fence at Washington, D. C.;

Sub-Committee XI on Paint Thinners other than Turpentine;

Sub-Committee XII on Turpentine;

Sub-Committee XIII on Shellac.

These reports will be presented by the chairmen of the respective sub-committees.

The following sub-committees have no formal reports to submit, but will continue their work and will doubtless present detail reports at the next meeting of the Society:

Sub-Committee VI on Definitions of Terms Used in Paint Specifications;

Sub-Committee IX on Varnish.

This report has been submitted to a letter ballot of the committee, which consists of 67 members. Forty-four ballots were cast, 23 not voting. The vote was taken on each section of this report. The following is the result of the ballot:

General report			44	affirmative,	none negative
Report of Sub-Committee		II	38	"	" "
" " "		III	43	"	" "
" " "		IV	41	"	1 "
" " "		V	43	"	none "
" " "		VIII	41	"	" "
" " "		X	42	"	" "
" " "		XI	41	"	" "
" " "		XII	42	"	" "
" " "		XIII	38	"	" "

Respectfully submitted on behalf of the committee,

P. H. WALKER,
Chairman.

G. W. THOMPSON,
Secretary.

ADDENDUM.

At a meeting held at Atlantic City, July 2, 1914, at which 32 members were present, it was decided to discontinue inspection of the Havre de Grace bridge tests and Sub-Committee II was instructed to dispose of the plates, giving one set to the Bureau of Standards, one set to the Institute of Industrial Research, and making such disposition of the third set as the sub-committee saw fit.

It was decided that no further inspection be made of the Atlantic City steel test fence, and Sub-Committee IV on Inspection of Steel Plates at Atlantic City was directed to prepare a report on the relation of the results obtained from the inspections of the Atlantic City test fence and the water test on which they were based, such report to be in the hands of the Secretary of Committee D-1 so that a copy can be sent to each member of the committee prior to the November meeting.

[NOTE.—The proposed Standard Definitions of Terms used in Paint Specifications were referred back to Committee D-1 for further consideration. See pages 25–27 for action taken on the above report.

For discussion on the report, see pages 351–355.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS

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PROPOSED STANDARD DEFINITIONS OF TERMS USED IN PAINT SPECIFICATIONS.

Standard.—A term designating a quality or qualities specified.

Equal to.—The use of this term should be avoided if possible.

Pure.—Standard, without adulteration.

Commercially pure.—Is not defined and should not be used in specifications, as it involves the absence of "*standard.*"

Adulteration.—The partial substitution of one substance for another.

Adulterant.—A substance partially substituted for another.

Bulk.—The bulk of a pigment shall be considered as the total volume of the pigment and the voids, and varies inversely as the specific gravity of that volume.

Voids.—The space between the particles of a pigment, even though occupied by air or by a vehicle, whether liquid or dried.

Opacity.—The obstruction to the direct transmission of visible light afforded by any substance, comparison being made with sections of equal thickness. The opacity in the case of pigments should be considered as referable to their opacity in a vehicle under standard conditions.

Covering power.—The use of this expression should be avoided as being confusing.

Hiding power.—The power of a paint or paint material, as used, to obscure optically a surface painted with it.

Spreading power. —The relative capacity of a paint or paint material, as used, of being brushed out to a continuous uniform paint film expressed in terms of the area to which a unit volume, as used, is applied.

Fineness.—A term used to denote the extent of sub-division and expressive of the number of particles of pigment in a unit volume exclusive of voids.

Crystalline.—Having a definite structure referable to one of the systems of crystallography.

Amorphous.—The opposite of crystalline.

Paint.—A mixture of pigment with vehicle, intended to be spread in thin coats for decoration or protection, or both.

Pigment.—The fine solid particles used in the preparation of paint, and substantially insoluble in the vehicle.

Vehicle.—The liquid portion of a paint.

Volatile thinner.—All that liquid portion of a paint, except water, which is volatile in a current of steam at atmospheric pressure.

Non-volatile vehicle —The liquid portion of a paint, excepting water, which is not a volatile thinner by the above definition.

Tinting strength.—The relative power of coloring a given quantity of paint or pigment selected as standard for comparison.

Color.—A generic term including the colors of the spectrum, white and black, and all tints, shades and hues which may be produced by their admixture.

Tint.—A color produced by the admixture of a commercial coloring material, excepting white, with a white pigment or paint, the white predominating.

Hue.—The predominating spectral color in a color mixture.

Tone.—The color which principally modifies a hue or a white or a black.

Drying.—The solidification of a liquid film, independent of change in temperature.

Drier.—A material containing metallic compounds added to paints for the purpose of accelerating drying.

Specific gravity.—The relative weight of a unit volume of a substance compared with the weight of the unit volume of water at defined temperatures.

Density.—This is a purely scientific term. Its use should be avoided in specifications.

Gallon.—The measured gallon is 231 cubic inches. Where a measured gallon is called for, the temperature at which it is to be measured should be specified. Where a weighed gallon is called for, the weight should be specified or obtained from the specific gravity of the material at a definite temperature.

Water.—Dissolved water or water not definitely or chemically combined.

Dry.—Containing no uncombined water.

APPENDIX I.

REGULATIONS GOVERNING COMMITTEE D-1.

NOTE.—These Regulations are supplementary to the Regulations Governing Technical Committees.

STATEMENT OF PLAN AND POLICY OF COMMITTEE D-1.

Committee D-1, on Preservative Coatings for Iron and Steel, was organized in 1902 to investigate the problem indicated by the title. The work of the committee has broadened however during the past few years so as to cover the preservation of materials of construction in general by paint and similar coatings. To meet these conditions the Executive Committee of the Society extended the scope to be covered by the work of the committee, so that it is now a "Committee on Preservative Coatings for Structural Materials." The growth and importance of the committee's work, furthermore, have been such that the committee has been re-organized with an Advisory Committee having executive powers, and a number of sub-committees with powers to investigate, etc., along specific lines.

It has become evident to the members of the committee that its membership should be enlarged by adding thereto technical men of ability and experience who are interested in preservative coatings, so that the committee would become an organization of paint chemists and experts within the American Society for Testing Materials. It is thought such a plan of organization will enable its members to confer with reasonable frequency on technical questions. These conferences, say three times a year, will be of inestimable value in aiding the work of the committee.

In order that the work of the committee shall develop on broad lines, and be of the greatest practical value in its field of investigation, it is most desirable that the experimenters be trained observers who appreciate the need of accurate observations and accurate methods of testing before expressing positive conclusions or recommending definite specifications. In this way the integrity and impartial position of the committee will

be maintained and all interested will be assured of just consideration. This plan does not involve any suppression of facts, but rather a clear distinction between facts and conclusions. There should be no hesitation in reporting facts and recommending definite specifications when the established facts warrant positive conclusions.

It is to be hoped that manufacturing and consuming interests will recognize the importance of the work which is being done, and that they will see the advisability of helping in this work by having technical representation on the committee.

The reports of the standing sub-committtees shall be presented by their respective chairmen, and in their natural sequence, at the annual meetings of the Society.

1. The Officers of Committee D-1 shall be a Chairman, a Vice-Chairman, and a Secretary, to be elected annually.

2. Members may be added to Commitee D-1 at any time, by appointment by the Advisory Committee after approval by the Executive Committee of the Society.

3. The following standing sub-committees and their chairmen shall be appointed by the Chairman of Committee D-1, abolishing all old sub-committees:

I. Advisory Committee.
II. On Inspection of Havre de Grace Bridge.
III. On Testing of Paint Vehicles.
IV. On Inspection of Steel Plates at Atlantic City.
V. On Linseed Oil.
VI. On Definition of Terms Used in Paint Specifications.
VII. On Influence of Pigments on Corrosion.[1]
VIII. On Methods of Analysis of Paint Materials.
IX. On Varnish.
X. On Inspection of White-Paint Test Fence at Washington, D. C.
XI. On Paint Thinners Other Than Turpentine.
XII. On Turpentine.
XIII. On Shellac.

The chairman of each sub-committee shall be designated by the Chairman of Committee D-1.

The Chairman of Committee D-1 shall appoint such other committees as may be necessary.

[1] This sub-committee has been discontinued.

4. All actions taken by Committee D-1 shall be subject to review and approval by the Executive Committee of the Society.

5. Three regular meetings of Committee D-1 shall be held: one at the annual meeting of the Society, one in the fall, and one in the spring of each year.

6. Absence from two consecutive regular meetings without notice to the chairman or secretary shall be considered as a resignation.

7. The policy of the Committee is that no reports of committee work be made public except over the chairman's signature.

REGULATIONS GOVERNING SUB-COMMITTEES.

1. Each sub-committee shall elect a secretary, who shall keep minutes of its meetings, etc., assist the chairman of the sub-committee in correspondence, notifying members of meetings, etc., and confer with the Secretary of Committee D-1 in the preparation of reports.

2. All records of sub-committees and their officers, shall ultimately be transmitted to the Secretary of Committee D-1, for filing.

3. No expense shall be incurred by any sub-committee excepting for postage or stationery, unless previously authorized by the Advisory Committee. Statements of the expenses of sub-committees shall be sent to the Secretary of Committee D-1, for payment quarterly, dating from July 1st.

4. These regulations shall go into effect at once.

REGULATIONS GOVERNING THE SAMPLING OF LIQUIDS FOR COOPERATIVE WORK.

Quantity of Sample.—All samples used for cooperative work shall consist of at least two quarts for each experimenter taking part in the work. Not less than one quart shall be sent to each experimenter and not less than one quart shall be held in reserve for each experimenter.

Preservation of Samples.—All samples shall be preserved in completely filled, suitable containers (the kind to be stated in each case).

Sample to Represent.—The sample shall truly represent the material it purports to be, and if produced in the United States shall be obtained directly at the factory where it is produced. If imported, it shall be obtained from an original unbroken container.

Supervision.—The sample shall be drawn at the factory or from the imported container under the supervision, whenever practicable, of a committee of three or more; but when it is not practicable to have a committee of three or more, one expert, who shall be in no way interested in the manufacture or sale of the particular material represented, may draw the sample. It is not necessary that the experts drawing the sample be members of Committee D-1, or of the American Society for Testing Materials. The committee or single expert drawing the sample shall see that it is placed in a suitable, filled container, properly sealed, and labeled with labels bearing the number of the sample, date and place of sampling and signatures of all members of the committee drawing same.

Information to Accompany Samples.—The committee or individual drawing the sample shall obtain as much information as possible regarding the sample, such as nature and source of raw material used in its preparation, method of manufacture, date and place of manufacture or importation, consular certificate, etc. This information shall be explicit and shall include the name and official position of the person or persons giving such information. This information shall be transmitted in letter form to the chairman of the sub-committee to whom the samples are to be sent.

Duty of Chairman of Sub-Committee or other Member of Committee D-1 having Charge of Cooperative Work on Liquids.—He shall verify the seals on the packages of samples and assure himself that they have been received in good condition, shall see that they are properly resampled into suitable containers of not less than one quart, which shall be properly sealed for distribution to those cooperating in the tests. He shall see that all samples sent out are in completely filled containers, and that a reserve stock at least equal in volume to all sent out is preserved in one or more completely filled and properly sealed containers. He shall compile all information available regarding

the history of the samples, which shall be furnished to all co-operators, either before or after the work on the samples is reported, but before any reports are presented for consideration to the whole committee.

The labels and seals used on all original samples shall be as follows:

AMERICAN SOCIETY FOR TESTING MATERIALS.

COMMITTEE D-1.

Sample of ..... No.....

Taken at.....on.....19.....

The undersigned committee certify that the sample described above and contained within has been taken, under their supervision, and according to the regulations governing samples of liquids for co-operative work by Committee D-1.

Signed .....

.....

.....

.....

On samples sub-divided by the chairman of the sub-committee the same seals shall be used; but the label need only bear the name of the material and number of the sample, with such additional information as may be deemed advisable by the chairman of the sub-committee making the distribution.

REPORT OF SUB-COMMITTEE II ON INSPECTION OF HAVRE DE GRACE BRIDGE.

Under instructions from Committee D-1 at a meeting held in Washington, D. C., early in November, 1913, Sub-Committee II, through its chairman, officially notified the Pennsylvania Railroad Co., in the person of Mr. H. R. Leonard, Bridge Engineer, under date of November 17, 1913, that in agreement with its report at the 1913 meeting of the Society, final action had been taken by Committee D-1 upon the following sections of the bridge, namely, Nos. 1, 4, 7, 9, 13, 15 and 19, and that these sections from that date were at the disposal of the company for repainting. Request was made, however, that the plate panels corresponding to the above bridge sections be left in place for future observations, the action in regard to the bridge proper being taken primarily in the interest of the structure.

The last inspection of the Havre de Grace bridge was held on May 1, 1914, with the same schedule of marking used previously, namely:

Excellent	10 to 8
Good	8 to 6
Fair	6 to 4
Poor	4 to 2
Failure	2 to 0

The attendance at this inspection was not as large as hoped for, probably owing to a general impression that last year's inspection report indicated that the value of the tests had about been reached.

The results of this inspection are given in Table I, showing ratings by individual members of Sub-Committee II, who were assisted in each case by a member of Committee D-1 who was not a member of the sub-committee. The results are given for each of the three different rates of spreading of each paint.

Table II shows average rating by these same individual inspectors of each paint, covering all rates of spreading.

TABLE I.—INSPECTION OF GENERAL SURFACE CONDITIONS.

600-SQ-FT. SPREADING RATE.

Paint No.	Aiken.	Sabin.	Polk.	P. H. Walker.	White.	Average.	Average, 1913.
1	7.0	7.0	6 0	4 0	7 0	6.2	7 3
2	0.0	3.0	2 0	0 0	0 0	1.0	3 9
3	7.5	8.5	7 0	5 0	7 0	7.0	7 5
4	5.0	5.5	6.0	3.0	5 0	4.9	6 7
5	8.0	8.0	9 5	6 0	8 0	7.9	7 7
6	7.5	8.0	8 7	4 0	7 0	7.0	8 0
7	6.0	5.0	6.0	3 0	6 0	5.2	6 8
8	6.0	6 0	8 5	3 0	6.0	5.9	7 3
9	0 0	2.0	2.3	0 0	0 0	0.8	5 1
10	8.0	9.5	9 5	7.0	8.0	8.4	8 5
11	8.0	9.0	9.5	9 0	8 0	8.7	8 9
12	8.0	8.5	9 5	8.0	8 0	8.4	8 3
13	5.0	3.0	6.5	3.0	5 0	4.5	6 3
14	7.0	8 5	8 5	6 0	7.0	7.4	8 5
15	0.0	0.0	0.0	0 0	0 0	0.0	1 1
16	7 0	6.0	8 0	3 0	7 0	6.2	7 5
17	7.0	6.0	7 0	2 0	6 0	5.6	7 0
18	7.0	7.5	7.3	3 0	7 0	6 4	8 1
19	4.0	5.5	5 0	1 0	4 0	3 9	5 4

900-SQ-FT. SPREADING RATE.

1	5.0	6.0	6 0	3 0	5.5	5 1	7.0
2	0.0	1.0	0 0	0 0	0.0	0 2	1.4
3	7.5	8 0	6 0	4 0	6.5	6 4	6.4
4	4 0	4 5	5 5	2 0	4.0	4 0	5.9
5	6.5	7.0	8 2	4 0	6.5	6 4	7.6
6	7.5	8.5	8 9	5 0	7.5	7 5	8.0
7	3.0	3.0	2.0	0 0	3.0	2 2	5.6
8	6.0	5 0	7 5	3 0	6.0	5 5	6.8
9	0.0	1.0	1.0	0.0	0.0	0 4	3.8
10	6.0	8.0	7.0	3.0	6.0	6 0	8.3
11	8.0	8.5	9.5	8.0	8.0	8 4	9.0
12	6.0	7.0	8.7	6.0	7.5	7.0	7.1
13	0.0	2 0	2 5	0.0	0.0	0.9	4.4
14	6.0	7.5	7.7	4.0	6.0	6 2	7.8
15	0.0	0.0	0.0	0 0	0.0	0.0	0.8
16	6.0	5.0	8.2	2.0	6.0	5.4	6.7
17	4.0	4.0	4 5	1.0	4.0	3 5	5.8
18	4.0	5.5	5.2	1.0	4.5	4.0	7.8
19	3.0	4.0	5.0	2.0	4.0	3.6	6.7

1200-SQ-FT. SPREADING RATE.

1	5.5	6.0	6.0	3.0	5.5	5 2	6 7
2	0.0	0 0	0.0	0.0	0.0	0.0	0.0
3	5.0	4.0	4.0	2.0	5.0	4 0	4 1
4	4.0	3.0	6.0	2.0	4.0	3.8	4 8
5	6.0	5.0	7.0	2.0	6.0	5.2	6 6
6	7.0	8.0	8.5	5.0	7.5	7 2	7 9
7	0.0	0.0	0.0	0.0	0.0	0 0	2 4
8	4.0	3.0	6.0	2.0	4 0	3.8	6 0
9	0.0	0.0	0.0	0.0	0 0	0.0	1.0
10	5.0	5.5	2.0	1.0	5 0	3 7	8.0
11	7.0	8.0	9.3	7.0	7.0	7 7	8 8
12	4.0	5.0	7.2	2.0	4.0	4.4	5 2
13	0.0	1.0	2.0	0.0	0.0	0.6	3 0
14	4.0	6.0	5.3	2.0	4.0	4.3	7.0
15	0.0	2.0	0.0	0.0	0 0	0.4	1 8
16	0.0	3.0	3.0	0.0	0 0	1 2	5 2
17	4.0	3.0	5.7	1.0	2 5	3 2	6 8
18	3.0	4.5	4 7	1.0	3 0	3 2	6.5
19	3 0	3.5	5 0	2 0	0 0	2 7	5 5

Tables I and II cover only general surface conditions; the several preservative coatings having reached such a stage that only this important point as to finding the protective value of the paints was considered.

Table III shows a classification of results in Tables I and II.

Table IV is a summary prepared from Table III.

It will be noted that the tables of ratings in the present report show comparative average results of last year's report, so that the average change in the paints can be noticed at a glance.

TABLE II.—INSPECTION OF GENERAL SURFACE CONDITIONS.

COMPILED AVERAGE OF ALL RATES—600, 900, 1200 SQ. FT.

Paint No.	Aiken.	Sabin.	Polk.	P. H. Walker.	White.	Average.	Average, 1913.
1	5.5	6.3	6.0	3.3	6.0	5.5	7.0
2	0.0	1.3	0.7	0.0	0.0	0.4	1.6
3	6.6	6.8	5.7	3.7	6.2	5.8	6.3
4	4.3	4.3	7.2	2.3	4.3	4.3	5.8
5	6.8	7.1	8.2	4.0	6.8	6.5	7.3
6	7.3	8.3	8.7	4.7	7.3	7.2	8.0
7	3.0	2.7	2.7	1.0	3.0	2.5	5.1
8	5.3	4.7	7.3	2.7	5.3	5.1	6.7
9	0.0	1.0	1.1	0.0	0.0	0.4	3.5
10	6.3	7.7	6.2	3.7	6.7	6.0	8.3
11	7.7	8.3	9.4	8.0	7.8	8.3	8.9
12	6.0	6.8	8.5	5.3	6.5	6.6	6.9
13	1.7	2.0	3.7	1.0	1.7	2.0	4.6
14	5.7	7.3	7.2	4.0	5.6	6.0	7.7
15	0.0	0.7	0.0	0.0	0.0	0.1	1.2
16	4.3	4.7	6.4	1.7	4.1	4.3	6.5
17	5.0	4.3	5.7	1.3	4.2	4.1	6.5
18	4.7	5.8	5.7	1.7	4.8	4.5	7.5
19	3.3	5.7	5.0	1.7	2.7	3.4	5.9

No particular classification of paints in connection with the various bridge sections has been attempted, because it is the opinion expressed generally by the members of the inspection committee at the present time and since the previous inspection, that the value of the tests has been practically reached at this time, and that in the interest of the structure itself, all the sections not previously turned over to the Pennsylvania Railroad Co. should be placed in their hands, if the opinion of the inspection committee is endorsed by Committee D-1. There is no doubt that a large part of the surfaces of the bridge sections are, in nearly every case, in as good condition

or better than the best panels corresponding to each paint, but the horizontal surfaces throughout the bridge are generally suffering by impairment of all of the coatings. When it is remembered that this test has been under way for eight years,

Table III.—Classification from Tables I and II.

Paint No.	Panel Spreading Rate, sq. ft. per gal.			Average.
	600	900	1200	
1	II	III	III	III
2	V	V	V	V
3	II	II	IV	III
4	III	IV	IV	III
5	II	II	III	II
6	II	II	II	II
7	III	IV	V	IV
8	III	III	IV	III
9	V	V	V	V
10	I	III	IV	III
11	I	I	II	I
12	I	II	III	II
13	III	V	V	V
14	II	II	III	III
15	V	V	V	V
16	II	III	V	III
17	III	IV	V	III
18	II	IV	IV	III
19	IV	IV	IV	IV

Table IV.—Summary from Table III, Showing the Paints Falling in the Various Classes.

Class.	De-cription.	Panel Spreading Rate, sq. ft. per gal.			Average.
		600	900	1200	
I	Excellent.	10, 11 12.	11.	.....	11.
II	Good.	1, 3, 5, 6, 14, 16, 18.	3, 5, 6, 12, 14.	6, 11.	5, 6, 12.
III	Fair.	4, 7, 8 13, 17.	1, 8, 10, 16.	1, 5, 12, 14.	1, 3, 4, 8, 10, 14 16, 17, 18.
IV	Poor.	19.	4, 7, 17, 18, 19.	3, 4, 8, 10, 17, 18, 19.	7, 19.
V	Failed.	2, 9, 15.	2, 9, 13, 15.	2, 7, 9, 13, 15, 16.	2, 9, 13, 15.

the condition of a considerable number of the different paints at this time indicates that with proper care in preparing metal surfaces, and proper supervision of the application of the paints, good protection can be assured for a much longer time than is

ordinarily considered the life of the general run of preservative materials.

Several of the coatings showing the best preservative character at the present time, and falling in the higher classes, are undoubtedly furnishing better protection—that is, on the vertical surfaces which are particularly considered in this report —than that furnished throughout much of the structure which was painted at the same time by the company, and not included in this test.

It is to be noted that the company has not at the present time taken any action towards repainting the seven sections of the bridge turned over to them last fall, and it may be concluded that they have possibly held off, anticipating the present recommendations of Committee D-1 that all the remaining sections be turned over to them for repainting, which would allow the work all being done at the same time.

Respectfully submitted on behalf of the sub-committee,

W. A. AIKEN,
Chairman.

[NOTE.—See Addendum, page 223.—ED.]

REPORT OF SUB-COMMITTEE III ON TESTING OF PAINT VEHICLES.

Tests on Chinese Wood Oils.

Two samples of Chinese wood oil, one commercial as obtained from the exporter by a large varnish manufacturer (sample No. 1), and the other pressed from Chinese-wood-oil nuts under the supervision of members of the committee (sample No. 2), were obtained for the committee tests.

The sample of commercial Chinese wood oil, which was submitted to the members of the committee as sample No. 1, was obtained from Mr. L. P. Nemzek, a member of the committee, from a large shipment received on Nov. 4, 1913. This oil had proved in actual factory tests made upon a big scale to be one of the best grades of commercial Chinese wood oil which had come to his attention. The samples were sent out to the members of the committee by Mr. Nemzek, in quart tin cans which had been previously thoroughly cleaned with naphtha. No attempt was made to filter the oil previous to sampling.

Mr. Percy H. Walker, Chief of the Contracts Laboratory of the Bureau of Chemistry, had charge of the pressing of the wood-oil nuts from which sample No. 2 was obtained. This sample, as prepared at the Bureau of Chemistry, U. S. Department of Agriculture, for the use of the sub-committee, was from nuts delivered to that laboratory by the Agricultural Explorer of the Bureau of Plant Industry; the nuts having been imported from China by C. L. Gillespie and Co., New York. Samples of the nuts were identified at the Bureau of Plant Industry by Mr. Skeels, as *Aleurites fordii*. Following is an analysis of a sample of the nuts as made by Mr. S. Ginsburg:

Average weight of nut, g	2.4
Shells (determined on 5.78 kg. of nut), per cent	41.6
Kernels by difference, per cent	58.4
Moisture in kernels (loss in CO_2 at 100° C.), per cent	2.6
Ash, per cent	2.2
Nitrogen, per cent	2.44
Ether extract, per cent	64.1
Ether extract from shells, per cent	1.0
Ether extract of press cake, per cent	7.2

One hundred and seventy-five pounds of the nuts were passed through a jaw rock crusher which was adjusted so that the nuts were cracked but not crushed. The kernels were then picked out by hand (102 lb.) and pressed in a laboratory size Anderson Expeller, without previous treatment (yield 35 lb.). The product at no time assumed a temperature other than that of the room.

The thick dark oil from the press contained a large amount of finely divided press cake. This was whirled in a centrifuge in cups and the almost clear supernatent oil thrown on filters. The sludge from the centrifuge cups and the expeller was sucked dry on a Buchner funnel. The several portions of the oil were then united and thoroughly mixed. Samples were drawn from the mixture and the containers sealed.

The total quantity of oil obtained was 35 lb. The nuts were pressed on October 2, 1913, and the filtration, which was quite slow, continued until October 8. The oil was mixed, canned, and sealed on October 11. Nine 1-qt. friction-top cans were filled with the oil. Eight of these samples were turned over to the chairman of the committee for distribution, and one sample was retained at the Bureau of Chemistry for work to be carried out by Mr. E. W. Boughton. The residual oil, of which there was approximately 15 lb., was placed in a large glass bottle with glass stopper, sealed, and the bottle painted black. This bottle is being retained at the Bureau of Chemistry under the supervision of Mr. Percy H. Walker.

The oil was prepared by Mr. S. Ginsburg, Assistant Chemist at the Contracts Laboratory, and was mixed and sampled by Messrs. Ginsburg, Boughton and Walker.

The Anderson Expeller was thoroughly cleaned before pressing, so that it is certain that the oil was obtained entirely from the kernels of the *Aleurites fordii*.

To each member of the committee was submitted by the chairman the attached outline of methods to be followed in examining the oils. In presenting the results of the work, the individual reports of each observer are given. In Tables I and II is presented a brief summary of the work.

Table I.—Summary of Results for Oil No. 1.

Observer.	Sp. Gr. at 15°.5/15°.5 C.	Refractive Index at 25° C.	Moisture and Volatile Matter, per cent.	Ash, per cent.	Acid Number.	Saponification Number.	Unsaponifiable Matter, per cent.	Iodine Number (Hubl, 18 hrs.)	Iodine-Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick	0.9395	1.5195	None	None	3.80	192.1	0.46	168.7	3–00	9–45
Lindsay	0.9411	1.5165	.....	0.0044	3.90	193.5	0.57	172.5	10–30	10–30
Pickard and Crown	0.9405	.....	0.02	0.004	3.15	192.65	0.73	169.5	2–15	11–45
Thompson and Mills	0.9399	1.5180	0.12	0.005	3.63	192.5	0.56	169.5	1–45	9–30
Voorhees and Wertz	0.9402	1.5174	0.04	0.004	2.74	193.3	0.50	172.2	9–15	11–30
Nemzek and Holkesvig	0.9398	.....	.....	.....	4.02	190.2	0.46	171.3	1–23	8–45
White and Boyle	0.9410	.....	0.02	0.0049	3.00	191.5	0.55	166.4	1–22	8–15
Bragg	.....	.....	0.065	0.005	2.55	192.0	....	.....	0–35	10–15
Coleman and Seaton	0.9421	1.4938[a]	0.019	0.019	3.41	191.8	0.454	168.2	4–00	9–00
Bacon	0.9398	1.5172	0.15	0.0117	3.89	191.8	0.69	166.2	3–16	9–07
Boughton	0.9417	1.5174	None	0.003	3.86	193.6	0.50	168.9	2–30	10–30
Average	0.9406	1.5176	0.012	0.0068	3.45	192.27	0.547	169.3	3–37	9–54

[a] The results of Coleman and Seaton on refractive index are not included in the average.

Recapitulation.

Constants of Oil No. 1.	Maximum.	Minimum.	Average.
Specific Gravity at 15°.5 C./15°.5 C	0.9421	0.9395	0.9406
Refractive Index at 25° C	1.5195	1.4938	1.5143
Moisture and Volatile Matter, per cent	0.15+	None	0.012+
Ash, per cent	0.019	None	0.0068
Acid Number	4.02	2.55	3.45
Saponification Number	193.6	190.2	192.27
Unsaponifiable Matter, per cent	0.73	0.454	0.547
Iodine Number (Hübl, 18 hours)	172.5	166.2	169.3
Iodine-Jelly Test, minutes and seconds	10–30	0–35	3–37
Heating Test (Browne's Method), minutes and seconds	11–45	8–15	9–54

TABLE II.—SUMMARY OF RESULTS FOR OIL NO. 2.

Observer.	Sp. Gr. at $\frac{15°.5}{15°.5}$ C.	Refractive Index at 25° C.	Moisture and Volatile Matter, per cent.	Ash, per cent.	Acid Number	Saponification Number.	Unsaponifiable Matter, per cent.	Number (Hübl, 18 hrs.).	Iodine-Jelly Test, minutes and seconds.	Heating Test (Browne's Method), minutes and seconds.
Gardner and Carmick.....	0.9390	1.5210	None	None	0.9	191.0	0.38	169.5	4–00	8–45
Lindsay.....	0.9406	1.5180	.....	0.0012	1.18	194.1	0.578	172.5	19–00	9–00
Pickard and Crown.....	0.9411	.....	0.0	0.0	0.59	192.75	0.56	169.7	1–35	11–15
Thompson and Mills.....	0.9393	1.5185	0.09+	Trace	1.04	193.1	0.50	170.0	2–00	9–00
Voorhees and Wertz.....	0.9409	1.5179	Trace	Trace	0.69	193.0	0.47	172.1	8–45	9–00
Nemzek and Holkesvig....	0.9396	.....	.....	.....	1.10	194.5	.....	167.6	.....	9–00
White and Boyle.....	0.9410	.....	0.015	0.00	0.70	193.0	0.53	167.4	1–15	8–00
Bragg.....	0.9330	.....	0.025	0.000	0.84	193.0	.....	.....	0–32	9–45
Bacon.....	0.9398	1.5180	0.09+	0.0063	1.06	193.4	0.423	167.6	3–01	8–30
Boughton.....	0.9415	1.5179	None	0.012	0.92	192.3	0.34	169.7	2–15	11–30
Average.....	0.9396	1.5186	0.02+	0.0026	0.90	193.02	0.473	169.6	4–43	9–23

RECAPITULATION.

CONSTANTS OF NO. 2 OIL.	MAXIMUM.	MINIMUM.	AVERAGE.
Specific Gravity at 15°.5 C./15°.5 C	0.9415	0.9330	0.9396
Refractive Index at 25° C	1.5210	1.5179	1.5186
Moisture and Volatile Matter, per cent	0.9+	None	0.02+
Ash, per cent	0.012	None	0.0026
Acid Number	1.18	0.59	0.90
Saponification Number	194.5	191.0	193.02
Unsaponifiable Matter, per cent	0.578	0.34	0.473
Iodine Number (Hübl, 18 hours)	172.5	167.4	169.6
Iodine-Jelly Test, minutes and seconds	19–0	0–32	4–43
Heating Test (Browne's Method), minutes and seconds	11–30	8–00	9–23

Methods for the Examination of Chinese Wood Oil.

1. *Specific Gravity.*—Use a pyknometer accurately standardized and having a capacity of at least 25 cc., or any other equally accurate method, making the test at 15°.5 C.; water being 1 at 15°.5 C.; or a test at 25° C.; water being 1 at 25° C.

2. *Refractive Index.*—Use a properly standardized Abbé refractometer at 25° C., or any other equally accurate instrument.

3. *Moisture and Volatile Matter.*—Heat about 5 g. of oil in an oven to 105° C. for 45 minutes. Perform the operation in an atmosphere of hydrogen, if possible.

4. *Ash.*—Burn about 20 g. of oil in a porcelain dish and conduct the ashing at as low a temperature as possible.

5. *Acid Number.*—Weigh 10 g. of oil in a 200-cc. Erlenmeyer flask, add 50 cc. of neutral alcohol, connect with a reflux air condenser (or place small funnel in neck of flask), and heat on a steam bath for ½ hour. Remove from the bath, cool, add phenolphthalein, and titrate the free acid with N/5 sodium hydroxide. Calculate as the acid number (milligrams of potassium hydroxide to 1 g. oil).

6. *Saponification Number.*—Weigh from 2 to 3 g. of oil in a 200-cc. Erlenmeyer flask, add 30 cc. of a N/2 alcoholic solution of potassium hydroxide, connect with a reflux condenser, heat on a steam bath for 1 hour, then titrate with N/2 sulfuric acid, using phenolphthalein as indicator. Always run two blanks with the alcoholic potash. From the difference between the number of cubic centimeters of acid required by the blanks and the determinations, calculate the saponification number (milligrams of potassium hydroxide to 1 g. of oil).

7. *Unsaponifiable Matter.*—To 25 g. of oil add 15 cc. of an aqueous solution of KOH (200 g. of KOH dissolved in water and made up to 300 cc.) and 35 cc. of 95-per-cent alcohol. Connect with a reflux condenser and heat on the water bath for 1 hour with occasional shaking. Transfer to a separatory funnel containing a little water and wash out flask with water, using in all 125 cc. Cool, add 200 cc. of ether and shake vigorously for 1 minute. In a few minutes the ether solution will separate perfectly clear. Draw off the soap solution into another separatory funnel. Shake the soap solution with three 100-cc. portions of ether. Unite all the ether portions and wash with three 30-cc. portions of water. Filter the ether solution (small portions at a time) into a tared flask, distill off the ether and dry flask and contents to constant weight at 95 to 100° C. in a steam oven. Report the percentage of unsaponifiable matter.

Those members of the committee who are able to do so are urged to make, in addition to the above determination, a determination of the unsaponifiable matter by one of the methods involving the extraction of the dry soap.

8. *Iodine Number (Hübl).*—Place a small quantity of the oil under examination into a small weighing bottle or beaker. Weigh carefully. Transfer by dropping from 0.2 to 0.3 g. to a 500-cc. bottle having a well-

ground stopper, or a specially flanged neck, iodine-test Erlenmeyer flask. Reweigh the weighing bottle or beaker to determine the amount of oil used in the test. Then dissolve the oil in 10 cc. of chloroform and add an amount of Hübl solution containing twice the amount of iodine that will be absorbed by the oil. Stopper the flask, shake well, and place in a dark closet for 18 hours. Add 20 cc. of a 10-per-cent solution of potassium iodide and 100 cc. of distilled water. Titrate with N/10 sodium thiosulfate, using starch as an indicator. Blank tests must be made. From the difference between the amounts of sodium thiosulfate required by the blanks and the determination, calculate the iodine number (centigrams of iodine to 1 g. of oil).

If desired, the committee members may repeat the Hübl iodine test, allowing varying periods of time from 4 to 18 hours for the absorption. These tests may determine whether an 18-hour absorption test is necessary.

On account of the fact that Hübl solution after preparation is apt to deteriorate in strength, it is considered advisable to have prepared the two component parts of Hübl solution, namely, a solution of mercuric chloride in alcohol and a solution of iodine in alcohol, of the proper strength, as outlined in text-books. The proper amounts of these solutions may be mixed on the day of use.

9. *Iodine-Jelly Test.*—Place 1 g. of oil (weighed out to within 1 mg.) in a porcelain evaporating dish of about 6 cm. diameter. Float the dish in a vessel containing water at 25° C., and add 5 cc. of chloroform from a pipette. Dissolve the oil by stirring with a glass rod and while stirring add 5 cc. of a solution of iodine in chloroform (saturated solution at 25° C.). Measure the iodine solution as accurately as possible in a small graduate, and add it all at once to the solution of the oil. Continue to stir until a jelly is formed. Note the time required for the formation of the jelly after the addition of the iodine solution and report time to the nearest quarter of a minute. The time will be about 1½ to 2 minutes. The saturated solution of iodine is prepared by adding an excess of iodine to chloroform at about 40° C., cooling to 25° C. in a water bath. The supernatent solution is taken for the test. The solution should contain 0.045 g. of iodine per cubic centimeter.

10. *Heating Test (Browne's Method).*—Test tubes for containing the oil should be 16 cm. by 15 mm., with a mark near the bottom to indicate 5 cc., and closed by a cork so perforated that a glass rod 3 mm. in diameter could move freely.

"Bath.—This was a copper beaker, height, 12 cm.; internal diameter, 6 cm.; filled with cotton-seed oil to a height of 7.5 cm.

"Thermometer.—The length was 30 cm. The graduations were from 100 to 400° C., and were verified by comparison with a standard instrument. In the experiments the thermometer was placed so as to be 1.5 cm. from the bottom of the bath. In ascertaining the temperature of the bath, due attention was given to the cool column of the mercury, so that corrected temperatures are recorded.

"Method of Procedure.—When the bath temperature is 293° C. (560° F.) and very slowly rising at this point, the tube containing 5 cc. of the oil

to be tested is fixed in so that the bottom of the tube is level with the lowest part of the bulb of the thermometer. The time is noted, and the source of heat is removed for about 45 seconds and then reapplied. Before 2 minutes have elapsed the temperature of the bath will have fallen to 282° C. (540° F.), at which point it should be kept as steady as possible. When the wood oil has been in the bath about 9 minutes, the glass rod is raised at intervals of ½ minute, and when the rod is firmly set the time is again noted. As setting or jellying takes place within a few seconds of fluidity, a good end determination is afforded. The specimen is at once removed, the bath is again heated to 293° C., and the experiment is repeated with another portion of the sample. There is no difficulty in obtaining results which do not differ by more than ½ minute. No stirrer is used in the bath. A screen around the bath enables the temperature to be more easily reached. When the cotton-seed oil has become tarry and viscid, it should be renewed; otherwise heating may be irregular. The jelly may be removed by half filling the tubes with strong sulfuric acid and placing in a warm place a few hours."

The above test is recommended because the conditions of making the test have been worked out in detail and because the result is recorded as a numerical value, for example, the number of minutes. The time will be about 12 minutes.

All members of the committee should make the heat test by the above method. In addition, if so desired, the heat test may be made by the Bacon, Worstall, or any other suitable method.

REPORTS OF ANALYSTS.

REPORT OF H. A. GARDNER AND L. G. CARMICK.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.9395	0.9390
Refractive Index[1] at 25° C	1.5195	1.5210
Moisture and Volatile Matter	None	None
Ash	None	None
Acid Number	3.8	0.9
Saponification Number	192.1	191.0
Unsaponifiable Matter, per cent	0.46	0.38
Iodine Number (Hübl)	168.7	169.5
Iodine-Jelly Test, minutes	3.0	4.0
Heating Test, minutes	9.75	8.75

Oil No. 1 was clear; oil No. 2 was cloudy and had a crystallin appearance.

[1] These oils apparently possessed the property of double refraction. The following results are obtained with an Abbé refractometer: Oil No. 1, 1.4980; oil No. 2, 1.4972. These readings are shown with dark bands not quite as sharp as the readings reported in above table. Tillyer has since stated that this double refraction may be prevented by heating the oil to 50° C. and then allowing to cool to 25° C., previous to using for refractive-index determinations.

REPORT OF R. W. LINDSAY.

	OIL NO. 1.	OIL NO.
Specific Gravity at 15°.5/15°.5 C	0.9411	0.9406
Refractive Index at 25° C	1.5165	1.5180
Moisture and Volatile Matter	Not determined	Not determined
Ash, per cent	0.0044	0.0012
Acid Number	3.90	1.18
Saponification Number	193.5	194.1
Unsaponifiable Matter, per cent	0.57	0.578
Iodine Number (Hübl)	172.5	172.5
Iodine-Jelly Test, minutes	10.5	19.0
Heating Test, minutes	10.5	9.0

Difficulty was found in operating iodine-jelly test. When the extra 5 cc. of chloroform are omitted in making the iodine-jelly test, the jelly is formed in about 2 minutes.

It was found impossible to make moisture and volatile determinations without use of hydrogen which was not available.

One cubic centimeter of the iodine solution used in the iodine-jelly test contained 0.0504 g. of iodine at 25° C.

REPORT OF GLENN H. PICKARD AND HARRY A. CROWN.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.9405	0.9411
Refractive Index at 25° C	Not determined	Not determined
Moisture and Volatile Matter, per cent	0.02	0.0
Ash, per cent	0.004	0.0
Acid Number	3.15	0.59
Saponification Number	192.65	192.75
Unsaponifiable Matter, per cent	0.73	0.56
Iodine Number (Hübl)	169.5	169.7
Iodine-Jelly Test, minutes	2.25	1.7
Heating Test, minutes	11.75	11.25

The iodine solution for the iodine-jelly test was not titrated.

REPORT OF G. W. THOMPSON AND C. B. MILLS.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.9399	0.9393
Refractive Index at 25° C	1.5180	1.5185

Report of G. W. Thompson and C. B. Mills—(*Continued*).

	Oil No. 1.	Oil No. 2.
Moisture and Volatile Matter		
In air, per cent, gain	0.12	0.09
In hydrogen, per cent, loss	0.11	0.07
Ash, per cent	0.005	Trace
Acid Number	3.63	1.04
Saponification Number	192.5	193.1
Unsaponifiable Matter, per cent	0.56	0.50
Iodine Number (Hübl)	169.5	170.0
Iodine-Jelly Test, minutes	1.75	2.0
Heating Test, minutes	9.5	9.0

Report of S. S. Voorhees and F. A. Wertz.

	Oil No. 1.	Oil No. 2.
Specific Gravity at 15°.5/15°.5 C	0.9402	0.9409
Refractive Index at 25° C	1.5174	1.5179
Loss at 105° C. for 45 min. in air, per cent	0.04	Trace
Ash, per cent	0.004	Trace
Acid Number	2.74	0.69
Saponification Number	193.3	193.0
Unsaponifiable Matter, per cent	0.50	0.47
Iodine Number (Hübl)	172.2	172.1
Iodine-Jelly Test, minutes	9.25	8.75
Heating Test, minutes	11.5	9.0
Color	Pale yellow	Pale straw
Appearance	Clear	Cloudy when cold
Odor	Characteristic odor of bacon	Very slight characteristic odor of bacon
Color (Liebermann-Storch reaction)	Claret	Claret

Refractive index determinations made by E. D. Tillyer. Details of iodine test and heating test probably need further investigation.

The method followed in making the iodine-jelly test was as follows: Chloroform was saturated with iodine at 40° C., the solution cooled to 25° C. and the supernatent solution poured off and used in the manner prescribed, without determining the iodine content. It was felt that as the solution was added from a graduate, accurate determination of the iodine content was not warranted. It is recommended that a more definite procedure be developed for this test, whereby the concentration and quantity of the iodine solution may be more accurately controlled.

REPORT OF L. P. NEMZEK AND C. A. HOLKESVIG.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.9398	0.9396
Refractive Index at 25° C	....	....
Moisture and Volatile Matter, per cent	....	....
Ash, per cent	....	....
Acid Number	4.02	1.1
Saponification Number	190.2	194.5
Unsaponifiable Matter, per cent	0.46	....
Iodine Number 4 hours (Hübl)	....	167.8
6 " "	.. .	163.9
18 " "	171.3	167.6
Iodine-Jelly Test:		
1st determination, minutes	1.25	....
2d determination, minutes	1.5	....
Heating Test:		
1st determination, minutes	8.5	9.0
2d determination, minutes	9.0	....

Iodine-jelly test results on oil No. 2 were not concordant. Oil No. 2 was in a condition resembling soft lard, when received.

The iodine solution for making the iodine-jelly test according to the method in the directions submitted, contained 0.043 g. of iodine per cubic centimeter. The solution of iodine was prepared by adding an excess of iodine to chloroform at about 40° C., cooling to 25° C. in a water bath. The supernatent solution was then taken off for use in making the test. The aim was not to make up a solution containing 0.045 g. of iodine per cubic centimeter, as it was taken for granted that the saturated solution prepared according to the directions would contain the proper amount of iodine. The solution containing 0.043 g. of iodine per cubic centimeter did not give concordant results.

REPORT OF G. D. WHITE AND C. BOYLE.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.941	0.941
Refractive Index at 25° C	Not determined	Not determined
Moisture and Volatile Matter, per cent	0.02	0.015
Ash, per cent	0.0049	0.00
Acid Number	3.0	0.7
Saponification Number	191.5	193.0
Unsaponifiable Matter, per cent	0.55	0.53
Iodine Number (Hübl)	166.4	167.4
Iodine-Jelly Test, minutes	1.4	1.25
Heating Test, minutes	8.25	8.0

REPORT OF G. D. WHITE AND C. BOYLE—(*Continued*).

Glass beaker used for heat test. Refined linseed oil bath used in place of cottonseed oil bath for heat test. Light color of refined oil makes it easier to note behavior of the wood oil under examination. Expect to work on oils at a lower temperature. May get valuable results.

The iodine solution used in making the iodine-jelly test was not titrated to determine whether it contained 0.045 g. of iodine per cubic centimeter; 45 g. of pure iodine to 1000 cc. of chloroform were used.

REPORT OF C. T. BRAGG.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C	0.9360[a]	0.9330
Refractive Index at 25° C	....	....
Moisture and Volatile Matter, per cent	0.065	0.025
Ash, per cent	0.005	0.000
Acid Number	2.55	0.84
Saponification Number	192	193
Unsaponifiable Matter, per cent	....	....
Iodine Number[b]	....	....
Iodine-Jelly Test, seconds	35	32
Heating Test, minutes	10.25	9.75

[a] At 25° C.

[b] Used Wijs solution for iodine number, which was 170 for each oil.

REPORT OF R. E. COLEMAN AND M. Y. SEATON.

	OIL NO. 1.
Specific Gravity at 15°.5/15°.5 C	0.9421
Refractive Index at 25° C	1.4938
Moisture and Volatile Matter,[1] per cent	0.019
Ash, per cent	0.019
Acid Number	3.41
Saponification Number	191.8
Unsaponifiable Matter, per cent	0.454
Iodine Number (Hübl)	168.2
Iodine-Jelly Test, minutes	4
Heating Test, minutes	9

[1] This determination made in air.

The analytical results reported are in every case the mean of several checking determinations.

The iodine-jelly test can be checked to ¼ minute. The Browne's heating test could not be consistently checked closer than 1 minute. All solutions were freshly standardized and the standards of all instruments checked so that these results are believed to be fairly accurate.

The iodine solution used in the iodine-jelly test was not titrated.

REPORT OF C. V. BACON.

	OIL NO. 1.	OIL NO. 2.
Specific Gravity at 15°.5/15°.5 C.	0.9398	0.9398
Refractive Index:		
At 15°.5 C.	1.5214	1.5221
At 25° C.	1.5172	1.5180
Moisture and Volatile Matter, per cent.	0.15	0.09
Ash, per cent.	0.0117	0.0063
Acid Number.	3.89	1.06
Saponification Number.	191.8	193.4
Unsaponifiable Matter, per cent.	0.69	0.423
Iodine Number (Hübl).	166.2[a]	167.6[b]
Iodine-Jelly Test.	3 min. 16 sec.[c]	3 min. 1 sec.[d]
Heating Test.	9 min. 7 sec.[e]	8 min. 30 sec.[f]

[a] Average of 7 determinations as follows:

Iodine Number, Hübl, new solution, temp. 15° C., all 18 hrs.	165.9 166.9 165.3
Iodine Number, Hübl, old solution, all run 18 hrs., max. temp. 26° C., min. temp. 15°.5 C.	164.8 165.9 167.3 167.0

[b] Average of 9 determinations as follows:

Iodine Number, Hübl, 18 hrs., new solution, temp. 15° C.	165.3 166.6 166.8
Iodine Number, Hübl, 18 hrs., varying temperature, using old Hübl solution, max. temp. 26° C.	169.1 166.9 168.2 169.8 168.4 167.7

[c] Average of 3 tests as follows:

Test No. 1, inside diameter dish, 3 in.; time, 3 min. 18 sec.
Test No. 2, inside diameter dish, 2⅝ in.; time, 3 min. 18 sec.
Test No. 3, inside diameter dish, 2⅝ in.; time, 3 min. 11 sec.

See remarks under note (*d*).

[d] Average of 3 tests as follows:

Test No. 1, inside diameter dish, 3 in.; time, 2 min. 57 sec.
Test No. 2, inside diameter dish, 2⅝ in.; time, 3 min. 10 sec.
Test No. 3, inside diameter dish, 2⅝ in.; time, 2 min. 56 sec.

Observer reported that although he followed directions exactly, he was unable to get more than 0.0403 g. of iodine in each cubic centimeter of solution. The strength of the iodine solution was determined by two titrations.

[e] Average of 3 tests as follows:

First test ran 9 minutes and product was solidified; start next test at 8 minutes.
Second test required 9 minutes for solidification.
Third test required 9 minutes, 20 seconds for solidification.

[f] Average of 3 tests as follows:

First test run as directed for 9 minutes, when tried was found to be solid; started trying others at 7 minutes.
Second test required 8 minutes for solidification.
Third test required 8½ minutes for solidification.

EXTRA TESTS.

	OIL NO. 1	OIL NO. 2
Color.	Light yellow, resembling Hong Kong oil.	Very pale yellow, far superior to any commercial grade.
Odor.	Mild of wood oil.	Faintly of Chinese wood oil.
Appearance.	Clear and bright.	Clear and bright.

REPORT OF C. V. BACON—(*Continued*).

EXTRA TESTS—(*Continued*).

	OIL NO. 1.	OIL NO. 2.
Tagliabue Viscosity	630 at 70° F.	642 at 70° F.
Free Fatty Acids (as Oleic), per cent	2.02	0.520
Drying Test (24 hours on glass)	Dry, hard	Dry, not hard

Moisture and Volatile Matter.—After 1 hour in water bath drying oven at 100° C., oil No. 1 gained in weight 0.15 per cent, oil No. 2 gained in weight 0.09 per cent.

Drying Test (24 Hours on Glass).—This test was made by placing a drop of the oil on a clean glass plate, then raising the same to a vertical position and leaving it in such position for 24 hours, after which time it is compared with a standard.

On many occasions it has been stated that drying on glass fails to give satisfactory results, yet I find it an excellent test for Chinese wood oil. I have been able to secure very concordant results even on different samples of pure oil, providing the tests are run at the same time. I find that the use of a regular glass plate is not very desirable, but by using a frosted plate I am able to get very close and concordant results. It is essential that the amount of oil used be practically the same and that the distribution be over the same area and spread uniformly. My results are as follows:

OIL.	MG. USED, G.	24 HRS.	48 HRS.	72 HRS.	96 HRS.
Bacon's Pure	0.1605	10.27	13.95	14.51	15.25
No. 2	0.1610	10.31	13.97	14.23	14.41
No. 1	0.1590	10.25	13.65	14.03	14.48

As may be seen, the above results check very closely and I might add that not only does the presence of foreign oils affect the drying of Chinese wood oil, but also affects the formation of the film, and I have run, in connection with the experiments, some of the same oil adulterated with bean and tea oil, which show a less oxygen absorption and causes an entirely different formation of the dried film.

HEAT TESTS.

Heat tests by three different methods were made. The results of Browne's method are given above. The other tests are as follows:

Worstall's Method.—Procedure for this test was as follows: 100 g. of oil were transferred to an ordinary tin saucepan, about $2\frac{1}{2}$ in. in depth, $3\frac{1}{2}$ in. in diameter at the bottom and $4\frac{3}{4}$ in. in diameter at the top. The oils were rapidly heated to 280° C.

Time required for oil No. 1 to reach the temperature of 280° C. was $3\frac{3}{4}$ minutes and after being at that temperature for $6\frac{3}{4}$ minutes, sample solidified and the resultant product was of good color, resembling good quality pale Hankow Chinese wood oil; it was dry and hard and cut well while hot, and under pressure gave a good fracture.

REPORT OF C. V. BACON—(*Continued*).

Time required for oil No. 2 to reach the temperature of 280° C. was 4 minutes. The oil was maintained at this temperature with constant stirring until solidification took place, the time required being 6½ minutes. The resultant product was very hard and firm, cutting good while hot, and the color an excellent pale yellow, and gave a good fracture when hot.

Bacon's Method.—Oil No. 1 solidified, being hard and firm and giving all indication of being pure oil but not as good as oil No. 2. A spatula passed from top to bottom 1 minute after removing from the bath gave a good clean cut. Oil No. 2 solidified in a very satisfactory manner, being hard and firm and giving a very good clean cut when a spatula was run through the hot mass from top to bottom. The polymerized product was very good in color and when the tube was broken it was found to be very hard and dry, giving all indications of being pure oil of excellent quality and superior to anything I have seen on the market within the last five years.

Conclusion.—Both oils are pure Chinese wood oils. While the quality of oil No. 1 is not as good as that of oil No. 2, both of them are superior to the oils with which they correspond, that are now on the commercial market, namely, Pale Hankow Chinese Wood Oil of fair average quality.

Oil No. 1 comes nearer a commercial oil and even this, while it may have been purchased on the open market, is exceptional in quality and gives indication of being warmed, filtered or settled. The average commercial oil is cloudy and of a red amber in color, and even when lighter and pale in color, it assumes practically the same color as the red amber oil; unless it is Hong Kong oil which always solidifies lighter than the Hankow oils, and has in recent years been subject to much adulteration.

REPORT OF E. W. BOUGHTON.

	Oil No. 1.	Average.	Oil No. 2.	Average.
Specific Gravity at 15°.6/15°.6 C.	0.9418 0.9415	0.9417	0.9414 0.9416	0.9415
Refractive Index				
At 25° C.	1.5174		1.5179	
At 15° C.	1.5212		1.5219	
Moisture and Volatile Matter	None		None	
Ash, per cent	0.002 0.005	0.003	0.017 0.007	0.012
Acid Number	3.81 3.90	3.86	0.83 1.01	0.92
Saponification Number	193.6 193.5	193.6	192.3 192.3	192.3
Unsaponifiable Matter, per cent	0.51 0.49	0.50	0.34 0.34	0.34

REPORT OF E. W. BOUGHTON—(*Continued*).

	Oil No. 1.	Average.	Oil No. 2.	Average.
Iodine Number (Hübl), 4 hrs.	167.2 166.5	166.9	169.2 170.9	170.3
6 hrs.	170.3	170.3	171.6 169.7	170.7
18 hrs.	168.6 169.2	168.9	169.7 169.6	169.7
Iodine-Jelly Test, minutes.....	$2\frac{3}{4}$ $2\frac{1}{2}$ $2\frac{1}{2}$ $2\frac{1}{4}$ $2\frac{1}{4}$ $2\frac{1}{4}$	2.25	$2\frac{1}{4}$ $2\frac{1}{4}$ .. 2	2.25
Heating Test, minutes.....	11 11 $10\frac{1}{2}$ 10	10.5	12 $11\frac{1}{2}$ 11 11	11.5

The iodine solution used in making the iodine-jelly test contained 0.0438 g. of iodine per cubic centimeter.

SUPPLEMENTARY REPORT.

Several tests in addition to those specified in the directions to the analysts were applied to the two samples sent out by the committee. The results are reported below, as are also the results of the examination of two samples of oil from the nuts of American-grown *Aleurites fordii*.

ADDITIONAL WORK ON COMMITTEE SAMPLES.

	Oil No. 1.	Oil No. 2.
Odor.....	like bacon	like bacon
Turbidity.....	none	none
Color in 4-in. layer.....	dark amber	light yellow
Color (depth of oil equivalent to Lovibond glasses, 21.5 yellow plus 2.5 red).....	34 mm.	200 mm.
Titer of mixed insoluble fatty acids.....	40°.7 C.	35°.8 C.
Rosin Tests:		
Color, Liebermann-Storch reaction	brown red, not like rosin.	brown red, not like rosin.
Color, Halphrn-Hicks test...	Pink to blue to purple, much like rosin.	Same as No. 1.

REPORT OF E. W. BOUGHTON—(*Continued*).

Oil No. 2, though clear when can was first opened, showed considerable precipitate after standing in the half-filled can.

The melting points of the mixed fatty acids were not sharp but were approximately, oil No. 1, 42 to 46° C.; oil No. 2, 36 to 39° C.

The iodine solution used for the iodine-jelly test contained 0.0438 g. of iodine per cubic centimeter. A mixture of 90 parts of oil No. 1 and 10 parts of linseed oil required 3½ minutes for the jelly formation.

The samples when heated in CO_2 as directed under "Moisture and Volatile Matter" gained slightly in weight. This also happened when heated in air.

	Oil No. 1.	Oil No. 2.
Gained in CO_2 per cent	0.02	0.04
" " Air " "	0.07	0.21

I have been unable to prepare fatty acids from Chinese wood oil which show an iodine number even as large as that of the oil, though the fatty acids were dried at 105° C. in CO_2. The iodine number of fatty acids prepared from oil No. 2 was 165.0. Attempts to separate the liquid and solid acids by the lead-salt ether method failed because still further oxidation took place during manipulation, and because the lead salt of elaeostearic acid is only partially soluble in ether.

The heating test by Bacon's method was made on oil No. 1. Eleven minutes were required for the polymerization. No correction was made for emergent stem.

Two portions of oil No. 1 were polymerized by heating ½ hour at 300° C. The loss in weight was 0.55 per cent. The resulting jelly was ground and extracted with petrolic ether (30 to 55° C.) in a Soxhlet apparatus. The amounts of extract were 23.05 per cent, 23.89 per cent, average 23.47 per cent. The iodine number of one extract was 104.8, of the other, 97.7. The portion insoluble in petrolic ether was treated with N/2 alcoholic potash in which it completely dissolved. The fatty acids, separated from the solution and dried at 105° C. in CO_2, were liquid and viscous, and did not congeal at 10° C. The iodine number (Hübl, 18 hours) was 101.6.

The molecular weight of the fatty acids of oil No. 1 calculated from the neutralization value (194.3) was 289; by the freezing-point method 286. The molecular weight of the fatty acids separated after saponification of the jelly obtained by heating ½ hour at 300° C., calculated from the neutralization value (198.7) was 282, by the freezing-point method, 306. It would seem from this that if actual "polymerization" occurred on heating, a depolymerization took place on saponification. As the jelly is insoluble in acetic acid, the freezing-point method could not be used directly.

The Utz test (Farbenztg., 18, 2531–3, C. A., 7, 4082) for sesame oil develops a red color in pure Chinese wood oil, which leads me to believe this test worthless.

Experiments on the Effect of Exposure to Light.—When exposed to sunlight Chinese wood oil becomes cloudy and finally changes to a white waxy

REPORT OF E. W. BOUGHTON—(*Continued*).

solid. The reason for this is that the glyceride of α-elaeostearic acid, which is present in the fresh oil together with olein, is changed to the glyceride of β-elaeostearic acid. This change has been investigated by Morrell,[1] who gives the melting points of the α and β acids as 48 and 71° C. respectively, and of the glyceride of the β acid as 48° C. The glyceride of the α acid is liquid at ordinary temperature. The oil after changing to a white wax shows the same figures for iodine number, saponification number, heating test (Browne) and iodine-jelly test as the original oil. The amount of change which has taken place is shown by the melting point or the titer of the fatty acids. As the oil contains about 15 per cent of olein, the titer of the fatty acids will always be lower than 71° C.

About 20 cc. of oil No. 1 were placed in each of several test tubes. The tubes were then exhausted with a vacuum pump, sealed, and placed side by side in a horizontal position. The exposure to sunlight was begun January 27, 1914. The titer of the fatty acids of the oil at the beginning of the experiment was 40°.7 C. The contents of one tube became cloudy in 2 days. The others were clear. At the end of 7 days the oil in every tube was cloudy and that in the tube that had shown cloudiness after 2 days was almost solid. This oil was saponified and the fatty acids separated, dissolved in ether and washed. The ether was distilled off and the acids dried in CO_2 at 105° C. The titer was 55°.2 C. The fatty acids from the oil in one of the other tubes, prepared the same way, had a titer of 48°.4 C. After this, at varying intervals a tube was removed and the titer of the fatty acids determined. At the end of 10 days the contents of every tube was a waxy solid, and as it was found to be difficult to dissolve the fatty acids in ether, the method of preparation was modified. The fatty acids were separated from the aqueous soap solution after saponification and the addition of water, and the mixture was boiled until the acids were clear. The oily layer was washed twice with boiling water and filtered into a titer tube. The fatty acids so prepared from the original oil showed a titer of 41°.1 C. which is but very slightly above the figure 40°.7 C. obtained with the fatty acids separated by solution in ether. The results of the experiment follow:

TIME OF EXPOSURE, DAYS.	TITER OF FATTY ACIDS, DEG. CENT.
0 (original oil)	40.7, 41.1
7	48.4, 55.2
13	49.2
20	50.8
24	52.3
39	53.7

I am unable to explain why one tube showed such a high figure after 7 days. The iodine number (Hübl, 18 hours) of the oil after 7 days was 170.9,

[1] *Journal*, Chem. Soc., Vol. 101, p. 208 (1912).

REPORT OF E. W. BOUGHTON—(*Continued*).

which is almost within experimental error of that of the original oil, 168.9. The fatty acids that showed a titer of 49°.2 C. (13 days exposure) were melted and made to cool and crystallize on the side of the tube, thus giving a large surface exposed to light. The tube was stoppered. After six days the titer was again determined and found to be 60°.0 C.; after remelting, cooling, and 19 days further exposure, the titer had risen to 60°.7 C. The fatty acids from an old sample of oil which had stood several months in a stoppered bottle showed a titer of 59°.1 C.

As shown by Morrell[1] the potassium salt of β-elaeostearic acid is insoluble in water and alcohol. Six grams of the fatty acids from oil No. 1 were dissolved in 100 cc. of 95-per-cent alcohol and neutralized with alcoholic KOH. The solution was cooled to 3° C. and the precipitate filtered off and washed with cold 95-per-cent alcohol. The potassium elaeostearate was dried and weighed. The equivalent weight of elaeostearic acid was 28.2 per cent of the total fatty acids. The filtrate was made up to 200 cc. with 95-per-cent alcohol and divided into two 100-cc. portions. One portion was exposed to light for 3 days which resulted in the formation of more precipitate. This was filtered off after cooling to 3° C., washed and weighed. The equivalent weight of elaeostearic acid, multiplied by 2, was 18.5 per cent of the total fatty acids taken. On further exposure of the filtrate for 2 weeks no further precipitation occurred. On evaporation to about 30 cc. and cooling, a very slight precipitate formed. The total elaeostearic acid precipitated as the potassium salt was then 46.7 per cent of the original fatty acids, but from the iodine number of the oil we know that the percentage of elaeostearic acid should be about 85. Evidently under these conditions, the formation of potassium β-elaeostearate from the α-salt is not nearly complete in 2 weeks. The method is, therefore, useless as a means of separation of oleic and elaeostearic acids. The second 100-cc. portion of the first filtrate was diluted with 200 cc. of water and cooled to 3° C. No precipitate formed. The fatty acids were liberated with HCl and alcohol added until the solution was clear. On exposure to sunlight for 2 weeks a precipitate weighing 30 mg. was formed. Its melting point was 70° C. so that it was practically pure β-elaeostearic acid. The filtrate after removal of this precipitate was neutralized with alcoholic KOH and the solution cooled to 3° C. No precipitate formed. On exposure to light for 2 weeks more a very slight precipitate formed. This method was also unsuccessful for the quantitative separation of elaeostearic acid.

[1] *Journal*, Chem. Soc., Vol. 101, p. 208 (1912).

REPORT OF E. F. DEYSHER ON ABSORPTION TEST ON CHINESE WOOD OILS.

OXYGEN ABSORPTION TEST, USING 10 G. OF PbO AND 0.5 G. OF OIL.

Time, days.	Gain in Weight, g.					
	Oil No. 1.		Oil No. 2.		Linseed Oil.	
1	0.9	0.4	1.2	0.6	9.8	10.2
2	2.2	1.1	5.1	4.1	12.9	13.1
3	4.0	2.3	7.2	6.6	13.8	13.6
4	7.4	6.1	8.6	8.3	13.4	13.0
5	8.4	7.6	9.2	8.8	13.1	13.0
6	8.9	8.8	9.7	9.5	12.8	12.8
7	9.1	9.1	10.0	10.0	12.7	12.7
8	8.9	9.0	10.1	10.0	12.5	12.6
11	9.0	8.8	9.8	9.8	11.7	11.9
13	9.1	9.1	9.8	9.8	11.8	11.9
14	9.1	9.1	9.8	9.8	11.7	11.8

These figures show that the gain in weight with Chinese wood oil is less than that with linseed oil. The results are in agreement with some figures previously published by this laboratory, which are different from those obtained by Meister.[1]

REPORT OF J. H. BOWER ON THE VISCOSITY OF CHINESE WOOD OILS.

	Oil No. 1.	Oil No. 2.
Viscosity, Engler, 20° C. (H_2O at 20° C. = 1)	38.9	39.4
Density, 20°/4° C	0.93652	0.93708
Time × Density (TD)	1860.49	1883.62
k	0.00151	0.00151
η	2.809	2.844

The viscosity at 20° C. of oil No. 1, determined with Ostwald viscosimeter, changed so rapidly as to be of no value, except in showing the rate of change.

$$k = 0.00127.$$

DETERMINATION NO.	TD	η
1	1696.60	2.155
2	1658.48	2.106
3	1629.54	2.069
4	1606.13	2.040

The Engler viscosities were run 3 or 4 hours before the Ostwald.

OIL NO.	SPECIFIC GRAVITY, 20°/20° C.	
1	0.93817 0.93818	0.93818
2	0.93875 0.93872	0.93874

[1] Chemical Abstracts, Vol. 5, p. 1523, (1911).

EXAMINATION OF SPECIAL TUNG OILS.

Three samples of oil were also examined by individual committee members. These samples were crushed from American-grown nuts supplied by Mr. Leo P. Nemzek. Samples Nos. 1 and 2 represented oils obtained from first crop nuts produced from tung-oil trees planted in Tallahassee, Fla., by David Fairchild of the Bureau of Plant Industry. Sample No. 1 was crushed at the Bureau of Chemistry by Messrs. Walker and Ginsburg, the following data being obtained at the time:

Average weight of nuts, g	3.3
Kernels, per cent	58.2
Loss of kernels in CO_2 at 100° C., per cent	2.41
Ash of kernel, per cent	2.47
Total nitrogen in kernel, per cent	2.05
Ether extract, per cent	68.0

The weight of the nuts received was 14.5 lb. The hulls were separated from the kernels pressed without previous treatment, in an Anderson Expeller. The thick dark oil from the press contained a large quantity of finely divided press cake and was filtered on a Buchner funnel.

Sample No. 2 was extracted at the North Dakota Experiment Station where the following data were obtained:

Analysis of Kernel: 63.5 per cent of kernel in whole nut; 1.08 per cent of moisture in kernel; 66.90 per cent of ether extract in kernel.

Yield of Oil: By extraction, 765 g. oil from 1710 g. of kernel = 44.73 per cent; by expression, 632.7 g. oil from 1710 g. of kernel = 37.00 per cent.

Sample No. 3 represented a candle-nut or lumbang oil crushed by Messrs. Walker and Ginsburg, at the Bureau of Chemistry, from nuts obtained by Mr. Leo P. Nemzek. The following data were obtained at the time:

Weight of nuts received, lb	74
(These were identified by Mr. Skeels, Bureau of Plant Industry, as *Aleurites molucana*. The nuts were very hard and had to be crushed by hand with a hammer.)	
Average weight of nuts, g	11
Kernels, per cent	30.0
Loss of kernel in CO_2 at 100° C., per cent	2.2
Ash of kernel, per cent	3.4
Total nitrogen in kernels, per cent	3.12
Ether extract of kernels, per cent	65.8

The kernels were pressed without previous treatment, in an Anderson Expeller, the oil from the press being filtered on a Buchner funnel.

The analytical data obtained upon these samples of American-grown oils are given in Table III.

TABLE III.—CONSTANTS OF AMERICAN GROWN OILS.

Sample No.	Observers.	Appearance.	Odor.	Refractive Index at 25° C.	Specific Gravity at 15°.5/15°.5 C.	Acid Number.	Saponification Number.	Iodine Number (Hübl, 18 hours).	Iodine-Jelly Test, minutes.	Heating Test (Browne's Method), minutes.	Titer of Fatty Acids, deg. Cent.
1[d]	Gardner and Carmick	Clear when received. Became cloudy over night.[a]	Neutral	1.5210	0.9390	0.8	192.6	170.8	8.0	10.5	.....
1	Boughton	Light yellow. Very light turbidity.	Very slight. Becomes pronounced on standing.	.....	0.9416	0.2	192.1	171.7	2.5	11.5	.....
2	Gardner and Carmick	Very light color.[b]	Neutral	1.5200	.....	0.4	190.2	165.9	8.0	10.0	.....
2	Boughton	White, waxy, solid.	Very slight.	.....	.....	0.4	192.4	165.3	3.0	11.5	59.1
3	Gardner and Carmick	Clear and light.	Neutral	1.4790	0.9276[c]	0.8	188.2	151.6	.....	.....	.....

[a] Became white granular solid in two days.

[b] Oil was partially crystallized when received; later it became solid throughout. Probably due to a polymerization by light. Heating to 35° C. restores oil to a clear, normal condition.

[c] At 15°/15° C.

[d] Samples Nos. 1 and 2 are tung oils; sample No. 3 is a lumbang oil.

TABLE IV.—CONSTANTS OF 8 SAMPLES OF RAW TUNG OIL AS TAKEN FROM THE RESULTS OF NINE OBSERVERS, AS REPORTED TO THE AMERICAN SOCIETY FOR TESTING MATERIALS IN 1913.

	MAXIMUM.	MINIMUM.	AVERAGE.
Specific Gravity at 15°.5/15°.5 C.	0.9436	0.9370	0.9407
Acid Number.....	12.50	0.84	5.69
Saponification Number.....	198.1	186.0	192.9
Iodine Number (Hübl, 18 hrs.)..	175.5	159.6	168.9

The close agreement of the analytical results as obtained by the different investigators for most of the constants, is very

encouraging. It is also noteworthy that the results of analyses of the special oils used this year check up very closely with the average results obtained with the various commercial oils used last year. These tests all indicate certain limits for the constants of pure Chinese wood oil. The committee, however, feels that specifications should not be drawn up at the present time, as confirmatory tests of an important nature are expected to be developed during the coming year.

The results obtained with American-grown tung oil also agree closely with the analyses of the foreign product. This should encourage the American agriculturist who intends to grow wood-oil trees in this country.

Respectfully submitted on behalf of the sub-committee,

H. A. GARDNER,
Chairman.

REPORT OF SUB-COMMITTEE IV ON INSPECTION OF STEEL PLATES AT ATLANTIC CITY.

At the 1913 meeting of the American Society for Testing Materials, Sub-Committee IV was authorized to remove one full set of painted steel plates to a suitable location, abandoning

TABLE I.—INSPECTION OF STEEL PLATES AT ATLANTIC CITY.

Formula No.	Types of Metal.	Composition of Paint.	Rating, 1914.
4	I II III	Sublimed White Lead	3.5
5	I II III	Sublimed Blue Lead	6
9	I II III	American Orange Mineral	3
10	I II III	Red Lead	4
12	I II III	Bright Red Oxide of Iron	2.5
14	I II III	Venetian Red	1.5
15	I II III	Prince's Metallic Brown	3
16	I II III	Natural Graphite	4
17	I II III	Artificial Graphite	0
19	I II III	Lampblack and Barytes	0
20	I II III	Willow Charcoal	4.5
21	I II III	Carbon Black and Barytes	5
24	I II III	French Yellow Ochre	1.5
34	I II III	American Vermilion	7.5
36	I II III	Medium Chrome Yellow	3.5
39	I II III	Zinc Chromate	4
40	I II ..	Zinc and Barium Chromate	2.5
41	I II III	Chrome Green	5
44	I II III	Prussian Blue	3.5
49	I II III	Zinc and Lead Chromate	4
51	I II III	Magnetic Black Oxide	4
90	I	Lampblack	0
100	I	Carbon Black	2
111	I	Burnt Umber, 60 per cent; Zinc Lead, 20 per cent; Zinc and Barium Chromate, 20 per cent	5.5
555	I	Lampblack, 40 per cent; Graphite 40 per cent; Barytes, 20 per cent	5.5
666	I	Red Oxide of Iron, 50 per cent; Carbon Black, 5 per cent; Barytes, 35 per cent; Chrome Yellow, 10 per cent	5
888	 III	White Lead, 20 per cent; Barytes, 40 per cent; Chrome Yellow, 35 per cent; Prussian Blue, 5 per cent	5
5555	I	Coal-tar Composition	0
444	.. IIB ..	Zinc Oxide, 60 per cent; Zinc Chromate, 15 per cent; Silex, 20 per cent: Whiting, 2 per cent Prussian Blue, 3 per cent	4.5

NOTE.—All tests made on pickled plates except No. 444.

those painted plates which had served their usefulness. Of the 49 tests which had been annually inspected and reported upon, 23 were rejected as not being suitable for further test. One complete set of panels, representing the remaining panels, was transferred from the fence at Dover Avenue to the ocean

end of Young's Million-Dollar Pier for further exposure. The panels were buttoned to the northwest railing of the pier, presenting their painted surfaces to a southeastern exposure.

An inspection of these tests was made on May 2, 1914, by Messrs. P. H. Walker, C. S. Neal, H. J. Force, and H. A. Gardner. The inspectors collectively examined each test and came to an unanimous conclusion as to proper ratings. By this method, individual reports were abolished. The usual system of markings was followed, 0 representing the lowest mark and 10 the highest.

The tests are arranged in the order shown in Table I, starting from the ocean end of the pier. The Arabic figures represent the formulas, while the Roman numerals represent the type of steel used: I for Bessemer, II for Open Hearth, III for Ingot Iron. The collective ratings are presented for each paint.

Respectfully submitted on behalf of the sub-committee,

H. A. GARDNER,
Chairman.

[NOTE.—See Addendum, page 223.—ED.]

REPORT OF SUB-COMMITTEE V ON LINSEED OIL.

In an endeavor to secure data that would enable it to strengthen the specifications for raw linseed oil, Sub-Committee V decided to secure two new samples of raw linseed oil from the 1913 crop of North American flaxseed and to send them out with the four original samples of raw linseed oil. The work to be done consisted of the determination of the specification constants, the determination of the percentage of insoluble hexabromides by the Eibner method, and a study of several methods for the determination of unsaponifiable matter.

In order that it might add more data to that already collected on boiled linseed oil, the sub-committee determined to secure four new samples of that oil made from 1913 crop of North American seed, and to determine on them the specification constants, the percentage of ash and its constituents, the percentage of insoluble hexabromides by the Eibner method, and the percentage of rosin present.

These samples were obtained by representatives of the food and drugs laboratories located in the cities where the oils were produced, shipped to the chairman of the sub-committee, bottled and sent by him to six observers.

Owing to press of other business, sufficient data were not in the hands of the sub-committee to enable it to make a full report. In another year the sub-committee expects to present the results of this work together with any in addition that it may be able to acquire.

A supplemental report by H. W. Bearce and E. L. Peffer on the density and thermal expansion of Linseed Oil is appended thereto.

Respectfully submitted on behalf of the sub-committee,

GLENN H. PICKARD,
Chairman.

APPENDIX I.

SUPPLEMENTARY REPORT ON DENSITY AND THERMAL EXPANSION OF LINSEED OIL.

By H. W. Bearce and E. L. Peffer.

About three years ago (April and May, 1911), 16 samples of raw linseed oil were examined and their density and thermal expansion determined at different temperatures from 10 to 40° C. The samples examined at that time were, with one exception, from seed produced in North America. One of the samples was from South American seed.

The results of the investigation were published in Vol. XI of the Proceedings of the American Society for Testing Materials, 1911, and also, together with the results of a similar investigation on turpentine, in Technologic Paper No. 9 of the Bureau of Standards.

At the meeting of the American Society for Testing Materials, in 1913, it was decided to continue the work on linseed oil and to make a similar investigation of turpentine. Samples of both linseed oil and turpentine were therefore collected under the direction of the Society and were delivered to those persons by whom the investigations were to be made. A complete set of these samples was assigned to Mr. S. S. Voorhees, of the Bureau of Standards, who in turn delivered to the authors such quantities as were required for the determinations of density and thermal expansion.

The work on turpentine was completed some months ago and the report duly transmitted to Sub-Committee XII on Turpentine of Committee D-1 under the title "Supplementary Report on the Density and Thermal Expansion of Turpentines."[1]

The work on linseed oil is reported herewith.

As stated in the supplementary report on turpentine, the method employed is described in detail in Vol. XI of the Proceedings of the American Society for Testing Materials, in Technologic Paper No. 9 of the Bureau of Standards, and also in the Bulletin

[1] See pp. 333-337.—Ed.

of the Bureau of Standards, Vol. 9, No. 3 (Reprint No. 197) and will not be repeated here. The results obtained and a comparison of these with those previously reported are here presented in Tables I and II.

Six samples of pure raw linseed oil and four samples of boiled linseed oil were examined and the density of each sample was determined at 15 and at 25° C. From these data the change of density per degree Centigrade was calculated and also the specific gravity of each sample at 15°.5 C., in terms of water at 15°.5 C. as unity, and at 25° C. in terms of water at 25° C. as unity. It is customary for specific gravities reported in the Proceedings of the Society to be given on the above bases, but

TABLE I.—DETERMINATION OF SPECIFIC GRAVITY.

Sample No.	Specific Gravity at		Change per deg. Cent.	Specific Gravity reduced to	
	15°/4° C.	25°/4° C.		15°.5/15°.5 C.	25°/25° C.
1 (3595)	0.93435	0.92743	0.000692	0.93489	0.93015
2 (3596)	0.93273	0.92583	0.000690	0.93327	0.92854
3 (3597)	0.93277	0.92588	0.000689	0.93331	0.92859
4 (3598)	0.93386	0.92701	0.000685	0.93440	0.92973
30 (3599)	0.93349	0.92665	0.000684	0.93403	0.92937
31 (3600)	0.93387	0.92701	0.000686	0.93441	0.92973
32 (3601)	0.93617	0.92915	0.000702	0.93672	0.93187
33 (3602)	0.94233	0.93537	0.000696	0.94288	0.93811
34 (3603)	0.93704	0.92995	0.000709	0.93758	0.93268
35 (3604)	0.93914	0.93203	0.000711	0.93969	0.93476

Nos. 1, 2, 3, 4, 30 and 31 are pure raw linseed oils.
Nos. 32 and 33 are linoleate boiled linseed oils.
Nos. 34 and 35 are resinate boiled linseed oils.

we would, in passing, point out that the practice is neither necessary nor desirable. The object of giving the specific gravity of a substance at two different temperatures is that they may be compared and the rate of change noted. Consideration of the matter makes it evident that if such a comparison is to mean anything, the two values must be in terms of the same unit; that is, for purposes of comparison all specific gravities should be in terms of water at the same temperature. When this is not the case it is as useless to attempt to make a direct comparison of specific gravities as it would be to attempt to compare directly two densities expressed in grams per cubic centimeter and in pounds per cubic foot.

The simple and logical method is to express all specific gravities in terms of water at some chosen temperature. It is not important what that temperature is so long as it is definitely stated. There are advantages, however, in choosing 4° C. as the standard temperature. Specific gravities so expressed will be numerically the same as densities expressed in grams per cubic centimeter. For example, specific gravity at 25° C. in terms of water at 4° C. as unity (usually expressed sp. gr., 25°/4° C.), is the same as density at 25° C. in grams per cubic centimeter.

In this connection it should be clearly understood that to express specific gravities in terms of water at 4° C. does not mean that the determinations must be made at 4° C. The choosing of a certain reference temperature means only the fixing of the size of the unit employed, and since the density of water at various temperatures is known, it is a simple matter for the experimenter to reduce all his specific gravities, taken at various temperatures, to the same basis. Results so reduced will mean infinitely more to those who would read intelligently the written work.

The source and history of the samples are as follows:

No. 1 (3595), raw linseed oil. Sample taken at Atlantic Mill, National Lead Co., February 2, 1909; bottled January 22, 1914.

No. 2 (3596), raw linseed oil. Sample taken at Hirst and Begley's, Chicago, February 3, 1909; bottled January 22, 1914.

No. 3 (3597), raw linseed oil. Sample taken at South Chicago Mill, American Linseed Co., February 3, 1909; bottled January 22, 1914.

No. 4 (3598), raw linseed oil. Sample taken at Minneapolis Mill, Archer-Daniels Co., February 13, 1909; bottled January 22, 1914.

No. 30 (3599), raw linseed oil. Sample taken at mill of Midland Linseed Products Co. by representatives of the St. Paul Food and Drug Laboratory, December 19, 1913, from 1913 seed; bottled January 22, 1914.

No. 31 (3600), raw linseed oil. Sample taken at Wright and Hill Mill, American Linseed Co., by representatives of the Chicago Food and Drug Laboratory, December 8, 1913, from 1913 seed; bottled January 22, 1914.

No. 32 (3601), linoleate boiled linseed oil. Sample taken at mill of Midland Linseed Products Co., December 19, 1913.

No. 33 (3602), linoleate boiled linseed oil. Sample taken at Atlantic Mill, National Lead Co., January 9, 1914.

No. 34 (3603), resinate boiled linseed oil. Sample taken at Minneapolis Mill, Archer-Daniels Co., February 12, 1913.

No. 35 (3604), resinate boiled linseed oil. Sample taken at Wright and Hill Mill, American Linseed Co., December 8, 1913.

After completing the experimental work which is here presented, it was learned for the first time that samples Nos. 1, 2, 3, and 4 were from the same source and were assumed to be identical with the four samples reported by fifteen chemists in Vol. IX of the Proceedings, and again by a smaller number of chemists in 1911. These samples were also among those examined by one of us and reported on in Vol. XI of the Proceedings.

A comparison of the work here presented for these samples with that presented in 1911 will serve a double purpose; first, from such a comparison may be formed a fair estimate of the

Table II.—Comparison of Results of Different Analysts at Different Periods of Time.

Specific Gravity at 15°.5/15°.5 C.

Analyst Reporting.	Year.	Sample No.			
		1	2	3	4
Average of 15	1909	0.9346	0.9331	0.9333	0.9344
Average of 7	1911	0.9342	0.9329	0.9331	0.9344
Bearce	1911	0.9350	0.9331	0.9332	0.9345
Bearce & Peffer	1914	0.9349	0.9333	0.9333	0.9344
Specific Gravity at 25°/25° C.					
Average of 15	1909	0.9296	0.9281	0.9283	0.9295
Average of 7	1911	0.9299	0.9285	0.9286	0.9297
Bearce	1911	0.9303	0.9284	0.9286	0.9298
Bearce & Peffer	1914	0.9302	0.9285	0.9286	0.9297

reliability of the work; and second, it may serve to show how great changes have occurred in the individual samples since they were taken in 1909, more than five years ago. It will be of interest to include in this comparison the average results from 15 analysts in 1909 and 7 analysts in 1911. It will be still more interesting to include, when available, the results of the several analysts of 1914. These are shown in Table II.

On page 197 of Vol. XI of the Proceedings of the Society a comparison is given in which a somewhat better agreement is shown for the results of 1909 and 1911. In this table the results

for 1909 were evidently not the simple average of the results of the 15 analysts. No explanation could be found of the method employed in calculating the average as tabulated.

The variations shown in the individual determinations given on page 157 of Vol. IX of the Proceedings and on page 200 of Vol. XI of the Proceedings, make it apparent that specific gravity determinations of a single observer by ordinary means, even when extraordinary care is exercised, should be accepted with caution and conclusions should not be too hastily drawn. Examination of the results referred to shows that the mean deviation of the individual determinations from the mean of all the determinations in each series is about five units in the fourth decimal place; while the maximum difference between two observers on the same oil at the same temperature is in some cases as much as three or four units in the third place.

Examination of the results obtained by Bearce in 1911 and by Bearce and Peffer in 1914, reported herewith, shows that for the same oils the specific gravities are in agreement to within two units in the fourth decimal place in one case, and in all other cases the greatest difference is one unit in the fourth place. If carried to five decimal places the agreement in most cases is somewhat better than one in the fourth place.

Determinations made on the samples of boiled oil showed that the increase in specific gravity on exposure to the air was very rapid. For example, sample No. 32 (3601) which was at first about 0.9367 at 15°.5/15°.5 C. increased to 0.9376 when left in the open densimeter tube for two days.

REPORT OF SUB-COMMITTEE VIII ON METHODS OF ANALYSIS OF PAINT MATERIALS.

Sub-Committee VIII reports as follows:

1. After reviewing the literature on the analysis of pigments, the methods appended hereto (Appendix I) were compiled for the analysis of white pigments. Acknowledgment is made to P. H. Walker, W. G. Scott, G. W. Thompson, H. A. Gardner, J. A. Schaeffer and others. These methods, together with those given for dry red lead (Appendix II), are submitted for the committee's consideration as to their suitability in paint analysis and may be more time-consuming than the rapid methods for factory control.

2. Cooperative work on dry red leads: One sample of red lead high in available oxygen and one with a much lower content were submitted, together with a circular letter giving the method in detail, to the members of the committee and several others. The list of analysts reporting and results are appended hereto (Appendix II), together with methods for the usual determinations made in red lead for paint purposes. As originally sent out, the method specified that the sodium-thiosulfate solution used should be standardized against decinormal potassium-dichromate solution as described in Bulletin No. 107, revised, Bureau of Chemistry, p. 136 (1908); however, our attention having been called to the tendency of this method of standardization to give too low an iodine number per cubic centimeter, experiments by members of the sub-committee showed an average of 0.3 per cent too low in iodine number, the error indicated by Julius Wagner.[1] A second letter was then sent to each of the cooperating analysts requesting that results also be reported based on the number obtained by standardizing the thiosulfate solution against pure, resublimed iodine.

The thanks of the committee and the Society are due the National Lead Co. for the two samples of red lead contributed.

[1] *Zeitschrift für angew. Chemie*, Vol. 11, p. 951 (1898).

The sub-committee purposes to review the literature and conduct cooperative tests on methods of analysis for other pigments before going into the subject of mixed paints.

Respectfully submitted on behalf of the sub-committee,

F. W. Smither,
Chairman.

APPENDIX I.

ANALYSIS OF WHITE PIGMENTS.

METHOD FOR VERY SMALL AMOUNTS OF IRON.

Lead Pigments.—Treat sample with HNO_3 (1:1) in usual manner, dilute with H_2O, add H_2SO_4 to precipitate bulk of lead (not necessary to evaporate down); cool, filter, wash with 1 to 2 per cent of H_2SO_4, make filtrate just alkaline with NH_4OH, then just acid with dilute HNO_3, determine iron colorimetrically by the thiocyanate method, using same amounts of reagents in preparing standards. If sample contains insoluble matter, filter out and wash with hot water till Pb-free, and to filtrate add H_2SO_4 and proceed as given. The insoluble is ignited, treated with HF and H_2SO_4 in usual manner, brought into solution (filter out any $BaSO_4$), and added to filtrate from $PbSO_4$. If necessary, solution may be made up to volume and aliquots taken.

Other Pigments.—Treat as above, omitting the addition of H_2SO_4.

GENERAL METHOD.

Color.—Compare with a sample selected as a standard. "Volume" or "apparent gravity" to be determined by the Scott volumeter. True specific gravity to be determined by means of a pyknometer, using c. p. benzole or by Thompson's method.[1]

Fineness Test.—Determine with No. 21 silk bolting cloth or a 300-mesh bronze wire screen. The Thompson classifier[2] may also be used, supplemented by a microscopic study.

A qualitative analysis of all pigments should first be made.

Basic Carbonate of Lead.

Basic carbonate of lead (white lead) should approach the composition $2PbCO_3.Pb(OH)_2$.

Moisture.—Moisture may be determined by heating 2 g. for 2 hours in a steam-jacketed oven at atmospheric pressure.

Total Lead.—If pure product is being examined, dissolve 1 g. in 20 cc. of nitric acid (1:1) in a covered beaker, heating till all CO_2 is expelled; wash off cover, dilute to about 120 cc. with hot water and heat till all basic salt is in solution. Filter off any insoluble, wash with hot water till Pb-free, ignite and weigh "insoluble matter." (Insoluble, if appreciable, should be examined for $BaSO_4$, SiO_2, and silicates.) To filtrate add 20 cc. of H_2SO_4 (1:1) and evaporate to fumes of SO_3, cool, add about 150 cc. of water and 150 cc. of ethyl alcohol; allow to stand *cold* 2 hours, filter on a Gooch crucible, wash with 95-per-cent ethyl alcohol, dry 1 hour at 110° C., and weigh $PbSO_4$;

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 407 (1913).

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. X, p. 601 (1910).

calculate to PbO or to basic carbonate. Instead of determining the lead as sulfate, the nitric-acid solution may be made slightly alkaline with NH_4OH or NaOH, then acid with acetic acid, and 10 to 15 cc. of a 10-per-cent solution of potassium dichromate added; heat till the yellow precipitate assumes an orange color. Let settle and filter on a Gooch crucible, washing by decantation with hot water till the washings are colorless, finally transferring all of the precipitate. Finally wash with 95-per-cent ethyl alcohol and then ether; dry at 110° C. for 1 hour and weigh $PbCrO_4$.

Complete Analysis.—This method with a pure white lead gives good results for CO_2 and H_2O, but the residue is only an approximation of the true PbO. In the absence of acetic acid or other organic matter, for example, unextracted vehicle, heat 1 g. in a porcelain boat in a current of dry CO_2-free air, absorbing the water in H_2SO_4 and $CaCl_2$ and the CO_2 in soda-lime or KOH solution (sp. gr. 1.27). By weighing the residue of PbO in the boat all the factors for determining the total composition are obtained. Calculate the CO_2 to $PbCO_3$ and the H_2O to $Pb(OH)_2$; excess H_2O is due to moisture.

Acetic Acid.—Thompson's method[1] is as follows: Eighteen grams of the dry white lead are placed in a 500-cc. flask, this flask being arranged for connection with a steam supply, and also with an ordinary Liebig condenser. To this white lead is added, 40 cc. of sirupy phosphoric acid, 18 g. of zinc dust, and about 50 cc. of water. The flask containing the material is heated directly and distilled down to a small bulk. Then the steam is passed into the flask until it becomes about half full of condensed water, when the steam is shut off and the original flask heated directly and distilled down to the same small bulk—this operation being conducted twice. To the distillate which is received in a larger flask is added 1 cc. of sirupy phosphoric acid to insure a slightly acid condition. The flask is then heated and distilled using a spray trap, to a small bulk—say, 20 cc. Steam is then passed through the flask until it contains about 200 cc. of condensed water, when the steam is shut off and the flask heated directly. These operations of direct distillation and steam distillation are conducted until 10 cc. of the distillate require but a drop of N/10 alkali to produce a change in the presence of phenolphthalein. Then the bulk of the distillate is titrated with N/10 sodium hydroxide, and the acetic acid calculated. It will be found very convenient in this titration, which amounts in some cases to 600 to 700 cc., to titrate the distillate when it reaches 200 cc., and so continue titrating every 200 cc. as it distills over.

If the white lead contains appreciable amounts of chlorine it is well to add some silver phosphate to the second distillation flask and not carry the distillation from this flask too far at any time.

Carbon Dioxide.—Determined by evolution with hydrochloric acid, weighing in soda-lime, KOH solution or by absorbing in $Ba(OH)_2$ solution and titrating or weighing the $BaCO_3$.[2]

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[1] *Journal*, Soc. Chem. Ind., Vol. 24, p. 487 (1905).

[2] See J. M. Camp's method for carbon in steel in Phillips, "Methods of Analysis in Pittsburgh District;" Dudley & Voorhees' method in Scott, "White Paints and Painting Materials," p. 84; and an article by Wysor, in *Chemical Engineer*, Vol. 11, p. 26.

Total Sulfuric Anhydride (in absence of $BaSO_4$).—Determined by dissolving in HCl and NH_4Cl, precipitating with Na_2CO_3 solution in excess, filtering, acidifying filtrate with HCl and precipitating as $BaSO_4$.

(In presence of $BaSO_4$). Determined as under basic sulfate of lead containing $BaSO_4$.

Sulfur Dioxide.—Weigh 2 g. into a 250-cc. beaker, add 100 cc. of distilled water that has been *freshly boiled* and *cooled*, then 5 cc. of concentrated HCl; stir thoroughly, let stand 15 minutes, and titrate with 0.01-normal iodine solution, using starch as indicator. Blank should be run on reagents and correction made.

Metallic Lead.—Weigh 50 g. of the sample into a 400-cc. beaker, add a little water and add slowly 60 cc. of 40-per-cent acetic acid and after effervescence has ceased boil on hot plate. Fill the beaker with water, allow to settle, and decant clear solution. Add 100 cc. of a mixture of 360 cc. of strong NH_4OH, 1080 cc. of water, 2160 cc. of 80-per-cent acetic acid and boil until all solution is complete. Fill beaker with water, allow to settle and decant clear solution. Collect residue on watch crystal, floating off everything but metallic lead. Dry and weigh. Result $\times$ 2 = percentage of metallic lead in sample.

Note.—If soluble barium compounds, as for example, $BaCO_3$, are present, the lead and barium are separated together as sulfates, the precipitate of $BaSO_4 + PbSO_4$ treated with hot acid ammonium-acetate solution, and the lead determined in the solution by the sulfate or chromate method. The $BaSO_4$ is weighed as such. If sample contains much calcium or magnesium, determine lead by chromate method, or separate the lead by a hydrogen-sulfide precipitation, dissolve PbS in hot dilute HNO_3 and determine lead as $PbSO_4$ or $PbCrO_4$. Iron, aluminum, zinc, calcium and magnesium may be determined in filtrate from PbS by usual methods.

BASIC SULFATE OF LEAD.

Moisture.—Heat 2 g. of the sample 2 hours in an air bath at 105° C.

Insoluble Matter.—Treat 1 g. of sample in a 600-cc. beaker with 20 cc. of water, 20 cc. of concentrated HCl and 10 g. of NH_4Cl; cover and heat about 10 minutes, then add about 400 cc. of water and boil 10 minutes. Filter and wash thoroughly with hot water. Ignite and weigh insoluble matter. If sample contains soluble silica, treat with HCl and H_2O and evaporate to dryness, then as above with H_2O, HCl and NH_4Cl, finally diluting and boiling.

Total Soluble Sulfates (in the Absence of $BaSO_4$).—Treat 0.5 g. of the sample with 5 cc. of water, 3 g. of NH_4Cl and 5 cc. of HCl saturated with bromine; digest (covered) on steam bath about 15 minutes, add 25 cc. of H_2O, neutralize with dry Na_2CO_3 and add about 2 g. more, boil 10 to 15 minutes; let settle, dilute with hot water, filter and wash with hot water; redissolve in HCl, reprecipitate as above and wash thoroughly with hot water. Acidify united filtrates with HCl, adding a slight excess; boil and

add slight excess of 10-per-cent $BaCl_2$ solution. Let stand on steam bath for 1 hour, filter, wash with hot water, ignite and weigh $BaSO_4$. Calculate to SO_3 (includes SO_3 formed from SO_2).

Total Soluble Sulfate (in the Presence of $BaSO_4$).—Treat 1 g. in a 600-cc. beaker with 10 cc. of H_2O, 10 cc. of strong HCl, saturated with bromine, and 5 g. of NH_4Cl, heat on a steam bath in a covered beaker for 5 minutes, add hot water to make about 400 cc., boil for 5 minutes, and filter to separate any insoluble material. (A pure pigment should be completely dissolved). Wash with hot water, ignite, and weigh the insoluble. Remove lead with Na_2CO_3 as above, making a double precipitation, acidify, and to the boiling hot filtrate add slowly, with stirring, 20 cc. of a 10-per-cent $BaCl_2$ solution; let stand for 2 hours on the steam bath, filter, wash, ignite, and weigh as $BaSO_4$ (includes SO_3 formed from SO_2). If sample contains much calcium this precipitate, after ignition, should be treated as under "gypsum."

Soluble Zinc Sulfate.—Boil 2 g. of the sample with 150 cc. of water and 50 cc. of alcohol for 30 minutes, filter, and wash with a mixture of alcohol and water (1 : 3). Heat filtrate to boiling and expel most of the alcohol; then determine SO_3 by usual method of precipitation with $BaCl_2$. Calculate to $ZnSO_4$ and to SO_3.

Total Lead and Zinc (in the Absence of Calcium and Magnesium).—Insoluble matter and soluble SiO_2, if present, should be removed before adding H_2SO_4. Dissolve 1 g. by boiling 15 minutes with 250 cc. of water and 20 cc. of concentrated HNO_3, add 5 cc. of concentrated H_2SO_4, and evaporate to copious fumes of SO_3; cool, add 250 cc. of water, let stand *cold* 2 hours, filter on Gooch crucible, wash with 1-per-cent H_2SO_4, ignite and weigh as $PbSO_4$.

Iron and aluminum, if present, should be removed before precipitating zinc. If Ca and Mg are also present, see method below. To determine small amounts of Fe, Al and Mn (in absence of Ca or Mg), a large portion of sample should be treated as above, the Pb removed as $PbSO_4$, Fe and Al precipitated with NH_4OH (redissolving and reprecipitating); ignite and weigh $Al_2O_3 + Fe_2O_3$. This precipitate may be fused with $KHSO_4$ and Fe determined volumetrically, if desired. In filtrate from Al and Fe, Mn, if present, may be determined by precipitating with NH_4OH and bromine, finally weighing as Mn_3O_4. Make filtrate up to volume and determine Zn in an aliquot as $Zn_2P_2O_7$, as ZnO or volumetrically with $K_4Fe(CN)_6$.

Evaporate the filtrate to about 100 cc., cool, add 5 g. of microcosmic salt dissolved in water, then add NH_4OH until the solution is just neutral to litmus paper. Add 2 drops of NH_4OH and 1 cc. of acetic acid, stir vigorously, heat on steam bath for 1 hour (the precipitate should assume a crystallin character and settle well). Filter on a Gooch crucible, wash with hot water, ignite at first at a low temperature and finally to redness, cool, and weigh as zinc pyrophosphate. Calculate to ZnO.

Total Lead and Zinc (in the Presence of Calcium and Magnesium).—With a sample containing calcium or magnesium salts the lead should be precipitated as sulfide from a slightly acid (HCl) solution, the PbS dissolved in hot dilute HNO_3 and the lead determined as sulfate. Filtrates from the PbS are boiled to expel

H_2S, a little bromine water added to oxidize iron (if present), boil to expel bromine, and then add NH_4OH in slight excess. Filter off any precipitate of $Fe(OH)_3+Al(OH)_3$; wash with hot water. (If appreciable, redissolve in hot dilute HCl and reprecipitate with NH_4OH, ignite and weigh $Fe_2O_3+Al_2O_3$). Manganese if present, can be precipitated by adding bromine and NH_4OH and warming; filter, wash with hot water, ignite and weigh as Mn_3O_4. Unite all of the filtrates, make slightly acid with acetic acid, heat to boiling and pass H_2S into the hot solution till saturated (20 to 30 minutes); add 5 g. of NH_4Cl and let stand 5 hours; filter, wash with hydrogen-sulfide water, dissolve the ZnS in hot dilute HCl, boil off the H_2S, filter out any separated sulfur and determine the zinc as $Zn_2P_2O_7$, as described. Calcium may be determined in the filtrate from the ZnS by expelling H_2S and then adding NH_4OH and ammonium oxalate in usual manner. Titrate with $KMnO_4$. In the filtrate from calcium determine magnesium in usual manner by precipitating with sodium-phosphate solution, finally weighing as $Mg_2P_2O_7$. When calcium and magnesium are present zinc is best determined volumetrically by Low's[1] ferrocyanide method. In the absence of iron and manganese, take the filtrate from the PbS, make alkaline with NH_4OH, then just acid with HCl; add 3 cc. of concentrated HCl, dilute to 250 cc., heat and titrate just as in standardizing the solution. When iron and manganese are present follow the method for oxidized ores as described by Low.

Lead may also be determined by boiling 1 g. of the sample in 50 cc. of water plus 100 cc. of a mixture of 125 cc. of 80-per-cent acetic acid, 95 cc. of strong NH_4OH and 100 cc. of water, diluting to about 200 cc., filtering out any insoluble, washing with above mixture and then precipitating with $K_2Cr_2O_7$, finally weighing as $PbCrO_4$. Zinc may be determined by boiling 1 g. of the sample with 30 cc. of water, 4 g. of NH_4Cl and 6 cc. of concentrated HCl; dilute to 200 cc. with hot water, add 2 cc. of saturated sodium thiosulfate solution and titrate in usual manner with ferrocyanide.

Sulfur Dioxide.—Digest 2 g. of the sample with frequent stirring in 100 cc. of freshly boiled *cold* water and 5 cc. of concentrated HCl; let stand 10 to 15 minutes, add an excess of 0.01 normal iodine solution and titrate back with 0.01 normal sodium-thiosulfate solution, using starch indicator. Report as SO_2. Run blank on reagents and make corrections.

Carbon Dioxide.—Determined as under basic carbonate of lead, noting precautions for sulfides, etc., under lithopone.

Calculations.—Report soluble SO_3 as $ZnSO_4$; deduct ZnO equivalent of the $ZnSO_4$ from total ZnO and report residue as ZnO. Deduct soluble SO_3 and SO_3 equivalent to SO_2 from total SO_3, calculate remainder to $PbSO_4$; subtract PbO equivalent of $PbSO_4$ from total PbO and report remainder as PbO.

ZINC-LEAD AND LEADED-ZINCS.

Zinc-lead and leaded-zincs (Ozlo white) are to be analyzed by methods given under "basic sulfate of lead."

[1] "Technical Methods of Ore Analysis," p. 209 (1906).

ZINC WHITE.

Moisture.—Heat 2 g. in an air bath at 105° C. for 2 hours.

Loss on Ignition.—Ignite 1 g. over Bunsen burner for 15 minutes. Soluble zinc sulfate, total sulfate, insoluble matter, CO_2, lead, zinc, iron, aluminum, SO_3, calcium and magnesium are to be treated as under "basic sulfate of lead."

LITHOPONE.

Lithopone (Ponolith, Jersey Lily White, Becton White, Charlton White, Orr's White) should contain about 69 to 70 per cent of barium sulfate, the remainder being zinc sulfide with small amounts of zinc oxide and carbonate.

ANALYSIS OF PURE LITHOPONE.[1]

Moisture.—Heat 2 g. of the sample for 2 hours at 105° C. There should be less than 0.4 per cent of moisture.

Insoluble and Total Zinc.—Take 1 g. in a 200-cc. beaker, add 10 cc. of strong hydrochloric acid, mix, and add in small portions about 1 g. of potassium chlorate; then heat on the water bath until about half of the liquid is evaporated. Dilute with hot water, add 5 cc. of dilute sulfuric acid (1 : 10); boil, allow to settle, filter, wash, ignite, and weigh the insoluble which will be total barium as barium sulfate, together with any other insoluble. Make a qualitative examination for alumina and silica (not likely to be present). Heat the filtrate from the insoluble to boiling, add sodium-carbonate solution, drop by drop, until all of the zinc is precipitated as carbonate, filter on a Gooch crucible, wash, ignite, and weigh as zinc oxide.

Zinc Sulfide.[2]—Digest 1 g. with 100 cc. of 1-per-cent acetic acid at room temperature for ½ hour, then filter and wash; determine the zinc in the filtrate as in the preceding analysis. The difference between the total zinc oxide and the zinc oxide soluble in acetic acid multiplied by 1.19749 gives the zinc present as sulfide. The zinc soluble in acetic acid may be reported as oxide, though it may be partly carbonate. This method of analysis assumes the absence of impurities such as salts of iron.

ANALYSIS OF LITHOPONE IN THE PRESENCE OF FOREIGN SUBSTANCES.[3]

Soluble Salts.—Wash 2 g. with hot water and determine the nature of the soluble salts.

Moisture.—Determine on 2 g. the loss in weight at 100 to 105° C.

Insoluble.—Oxidize 1 g. with nitric acid of 40° Be. (sp. gr. 1.38), at first cold, then hot. Then add hydrochloric acid, evaporate to very small volume, dilute with hot water, filter, ignite the precipitate which represents the barium

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[1] Method of P. Drawe, *Zeitschrift für agnew. Chemie*, Vol. 15, p. 174 (1902).

[2] Scott's Evolution Method (following) may be advantageously used.

[3] Method of Copalle, *Ann. chim. anal. appl.*, Vol. 12, p. 62 (1907).

sulfate, corresponding to the total barium. If the insoluble exceeds 66 to 68 per cent it is necessary to prove that the excess is not due to the addition of kaolin.

Total Zinc.—Determine as oxide by precipitation as carbonate in the filtrate from the insoluble. When more than traces of iron, alumina, or lime are present, it is best to determine the zinc volumetrically.

Sulfide of Zinc.—Add a slight excess of hydrochloric acid to the filtrate from the zinc carbonate and determine the sulfur by precipitation in the usual manner. This sulfur multiplied by 3.0383, or the weight of barium sulfate ($BaSO_4$) multiplied by 0.41741, gives the zinc sulfide.

Oxide of Zinc.—Multiply the weight of the zinc sulfide by 0.83507 to obtain the zinc oxide corresponding to the sulfide. Subtract this from the total zinc oxide and report the remainder as zinc oxide (it may be present as oxide or as carbonate).

Barium Carbonate.—Digest 2 g. with boiling dilute hydrochloric acid, dilute with hot water, filter from the insoluble and determine the barium in the filtrate by precipitation with sulfuric acid. The weight of the barium sulfate multiplied by 0.84548 gives the barium soluble in the acid calculated as carbonate.

Barium Sulfate.—Subtract the barium sulfate corresponding to the carbonate from the total barium sulfate.

Sulfide may be determined directly by Scott's[1] evolution method, using 0.5 to 1 g. of pigment, mixing in evolution flask with zinc and water, running in HCl from separatory funnel and absorbing the H_2S in alkaline lead-nitrate solution. Filter off the PbS, dissolve in hot dilute HNO_3 and determine the lead as $PbSO_4$ or $PbCrO_4$. Calculate to ZnS ($PbSO_4 \times 0.3217$).

Carbon Dioxide.—Carbon dioxide may be determined directly by evolution method by grinding 1 g. of sample with excess of potassium dichromate (dry salt); transfer to flask, add 50 cc. of water and run in H_2SO_4 (1 : 1) from separatory funnel, absorbing CO_2 in KOH, soda-lime or $Ba(OH)_2$ solution. A tube containing $KMnO_4$ solution or acidified $CuSO_4$ solution may be placed in train as a precaution.

CALCIUM PIGMENTS.

WHITING, PARIS WHITE, SPANISH WHITE, AND CHALK.

Whiting, Paris white, Spanish white, and chalk are the natural and artificial forms of calcium carbonate.

Moisture.—Heat 2 g. of sample in an air bath at 105° C. for 2 hours. Loss in weight is considered as moisture.

Loss on Ignition.—Ignite 1 g. over blast lamp to constant weight.

Complete Analysis.[2]—Boil 2 g. of the sample in a covered vessel with

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[1] Scott, "White Paints and Painting Materials," p. 257.

[2] For refined methods of analysis, see Hillebrand, "The Analysis of Silicate and Carbonate Rocks," *Bulletin No. 422*, U. S. Geological Survey.

30 cc. of HCl (1 : 1) and a few drops of HNO_3; wash off cover and evaporate to dryness, take up with a little HCl and about 100 cc. of hot water; boil, filter, wash with hot water, ignite and weigh insoluble matter. Insoluble should consist of silicious matter. Test insoluble for $BaSO_4$. Heat filtrate from insoluble to boiling, having added more HCl in order to form sufficient NH_4Cl to hold magnesia in solution, and add NH_4OH in very slight excess, heat a few minutes, filter, wash with hot water, ignite and weigh $Al_2O_3 + Fe_2O_3 (+TiO_2 + P_2O_5)$. It is best to redissolve this precipitate in hot dilute HCl and reprecipitate with NH_4OH. (If manganese is present, it may be precipitated in the united filtrates from Al and Fe by H_2S and NH_4OH.) Unite the filtrates and make up to a definite volume, mix and take an aliquot corresponding to 0.5 g. of sample; dilute if necessary, heat to boiling and add slowly 30 cc. of a saturated ammonium-oxalate solution, let stand on steam bath 1 to 2 hours; filter, redissolve precipitate in dilute HCl, dilute, add 10 cc. of ammonium-oxalate solution and NH_4OH till alkaline, let stand on steam bath 1 or 2 hours; filter, wash with hot water till free from chlorides. The precipitate may be ignited to constant weight in a platinum crucible over a Meker burner and the CaO weighed as such, or the CaO may be determined volumetrically as follows:

The precipitate of calcium oxalate must be washed till 10 cc. of the washings plus 0.5 cc. of H_2SO_4 heated to 70° C. do not decolorize 1 drop of about N/10 $KMnO_4$ solution. The beaker in which precipitation was made is placed under funnel, apex of filter is pierced with stirring rod and the precipitate washed into beaker; then pour hot dilute H_2SO_4 (1 : 4) over paper, wash with hot water, add about 30 cc. of the dilute H_2SO_4 (1 : 4), dilute to about 250 cc., heat to 80 to 90° C., and titrate with about N/10 $KMnO_4$ (Fe value of $KMnO_4 \times 0.50206 = CaO$ value). Evaporate the united filtrates from the calcium oxalate to about 200 cc.—should any magnesium oxalate separate, dissolve it by adding a little HCl—add 5 cc. of NH_4OH, heat to boiling and add 10 to 15 cc. of saturated Na_2HPO_4 solution. Add a few cubic centimeters more of NH_4OH, cool in ice water with vigorous stirring. Let stand 2 to 4 hours, filter on a Gooch crucible, wash with 2-per-cent NH_4OH containing a little NH_4NO_3; ignite gently at first and finally at a bright red for 5 or 10 minutes, cool and weigh as magnesium pyrophosphate. Calculate to MgO. If magnesium is high, or for very accurate work, the NH_4MgPO_4 should be redissolved in dilute HCl and the Mg reprecipitated as above. If MgO is very low, it may be necessary to destroy the ammonium salts in the filtrate from the calcium oxalate before precipitating the MgO. This may be effected by evaporating to dryness with excess of HNO_3, taking up with HCl and water, filtering and proceeding as above.

Carbon Dioxide.—Determined by evolution method as under basic carbonate of lead.

Total Soluble Sulfates.—Determined as under gypsum.

Alkalinity.—Alkalinity is due to free lime or possibly to sodium or potassium compounds. Boil 2 g. of the sample for 5 minutes with 100 cc. of water, filter, add phenolphthalein. If a red color develops, free lime may be assumed to be present. Titrate with N/10 acid.

GYPSUM, TERRA ALBA, PLASTER OF PARIS.

Gypsum is a natural hydrated calcium sulfate, $CaSO_4.2H_2O$; terra alba is a fairly pure grade of raw gypsum; plaster of Paris is a calcined or dehydrated calcium sulfate—$CaSO_4.\frac{1}{2}H_2O$. There is also a precipitated calcium sulfate used as a basis for aniline lakes.

A microscopic examination may be of importance.

Moisture.—Dry 2 g. in vacuum desiccator over H_2SO_4 to constant weight.

Combined Water and Moisture.—Heat 1 g. of the sample in a covered porcelain crucible on an asbestos plate for 15 minutes, then heat bottom of crucible *dull red* for 10 minutes over a Bunsen burner, remove cover and heat for 30 to 40 minutes at a slightly lower temperature. Cool and weigh rapidly. Repeat to constant weight.

Combined water and moisture may also be determined by heating in air bath at 200° C. to constant weight.

Soluble and Insoluble.—Boil 2 to 3 g. of the sample with 20 cc. of concentrated HCl, a few drops of HNO_3, and about 50 cc. of water; evaporate to dryness, boil residue repeatedly with 10-per-cent HCl; filter, wash with hot water, ignite and weigh insoluble matter. Test for $BaSO_4$—make filtrate up to 500 cc. and mix. To 200 cc. add about 2 g. of NH_4Cl and NH_4OH till slightly alkaline, heat till only faint odor of NH_4OH remains, let settle, filter, wash with hot water, ignite and weigh $Al_2O_3+Fe_2O_3$. Heat filtrate from Al and Fe to boiling and add about 40 cc. of saturated ammonium oxalate solution, let stand on steam bath 2 hours; filter, redissolve precipitate in hot dilute HCl, add 10 cc. of ammonium-oxalate solution and NH_4OH till alkaline, let stand 1 hour on steam bath; filter, wash with hot water till free from soluble oxalates (see test under whiting), and proceed as under whiting, titrating with $KMnO_4$. The united filtrates from the lime are evaporated and MgO determined as under whiting.

Soluble Sulfate.—Make 200 cc. of the filtrate from the insoluble slightly alkaline with NH_4OH, then acid with HCl, heat to boiling and add 20 cc. of hot 10-per-cent $BaCl_2$ solution, stir well. Let stand at least 1 hour on steam bath; filter, wash with hot water till washings give no test for Cl with $AgNO_3$, ignite, cool, and weigh $BaSO_4$. For very accurate work, the weighed $BaSO_4$ should be purified by treating with dilute HCl, filtering, washing, igniting and again weighing.

Carbon Dioxide.—Determined by evolution, weighing in soda-lime, KOH bulb or as $BaCO_3$.

QUICKLIME AND SLAKED OR HYDRATED LIME.

Quicklime (CaO), and slaked or hydrated lime ($Ca(OH)_2$), are used in the preparation of cold-water paints, for example, whitewash. These materials may be examined as under whiting.

Strontia white, $SrSO_4$, and strontianite, $SrCO_3$, occur only in small

quantities and are rarely met with in paint analysis. In the usual methods[1] of analysis any strontium present is weighed with the CaO or reported as $BaSO_4$ when insoluble.

BARIUM PIGMENTS.

BARYTES OR BARITE.

Barytes or barite is a natural sulfate of barium; "blanc fixe" is precipitated barium sulfate. Being one of the cheapest white pigments, this material is seldom adulterated. It should be white, well-ground and contain not less than 95 per cent of $BaSO_4$. A microscopic examination can be made with advantage to determine uniformity of grinding, size and angularity of particles, amorphous or crystallin. Miscibility, opacity, specific gravity, volume, whiteness of color, together with microscopic study probably give more information than chemical analysis. However, the following method may be used:

Moisture.—This equals the loss in weight on heating 2 g. of the sample at 105° C. for 2 hours.

Loss on Ignition.—Ignite 1 g. of sample for 30 minutes (to constant weight). Loss may be due to organic matter, free and combined water, and CO_2. Report as "loss on ignition."

Insoluble.—Boil 1 g. with HCl (1 : 3), evaporate to dryness, moisten with HCl, add water, boil, filter, wash with hot water, ignite in platinum crucible if previous qualitative examination has determined the absence of lead or other easily reduced metals. Weigh insoluble and treat with H_2SO_4 and hydrofluoric acids in usual manner, evaporate, ignite and weigh, loss is silica; residue should be $BaSO_4$. The residue may be fused with Na_2CO_3, taken up with hot water, acidified with HCl, the $BaSO_4$ filtered off, washed, and ignited. If weight so obtained differs materially from that of residue from hydrofluoric-acid treatment, examine last filtrate for Al, Fe, Ca and Mg that may have remained as residue from silicates.

Alumina, Iron Oxide, etc.—Add NH_4OH to the filtrate from the total insoluble, boil, filter, wash, ignite and weigh as $Fe_2O_3+Al_2O_3$. In filtrate determine Ca and Mg as in gypsum.

Soluble Sulfate.—Boil 1 g. with 20 cc. of concentrated HCl, dilute to 200 cc. with hot water, boil, filter, wash, add NH_4OH to filtrate till just alkaline, make just acid with HCl, boil, add 10-per-cent $BaCl_2$ solution and weigh $BaSO_4$ in usual manner. Calculate to $CaSO_4$. If carbonates are present, calculate the remaining CaO to $CaCO_3$. Any excess of CaO is reported as CaO.

Carbon Dioxide.—Determine by evolution method as given under basic carbonate of lead.

Barium Carbonate.—If present, it may be precipitated in first filtrate before determining Al, Fe, etc., by adding 10-per-cent ammonium-sulfate

[1] For methods see *Bulletin No. 422*, U. S. Geological Survey; Treadwell-Hall, "Analytical Chemistry," etc.

solution containing a little free H_2SO_4, finally weighing in usual manner as $BaSO_4$. Any excess of CO_2 over the barium here found is calculated to $CaCO_3$.

Iron.—If in very small amount, determine colorimetrically as given under "Method for Very Small Amounts of Iron."

Water-Soluble.—This test is sometimes applied to blanc fixe. Boil 5 g. for 15 minutes with 100 cc. of water, filter and wash. Evaporate filtrate to dryness in a weighed dish, dry 30 minutes at 105° C., cool and weigh. Test for sodium, chlorine, $CaSO_4$, etc.

Witherite ($BaCO_3$).—This may be examined by preceding methods.

SILICA PIGMENTS.

SILICA OR SILEX.

Silica or silex (SiO_2) should be finely ground and white.[1]

Moisture.—This equals the loss in weight on heating 2 g. at 105° C. for 2 hours.

Loss on Ignition.—Ignite 1 g. to constant weight in a platinum crucible.

Insoluble Matter.—Boil 2 g. of the sample for 30 minutes with 50 cc. of HCl (1 : 1), add 50 cc. of water, filter, wash, ignite, and weigh insoluble matter, which should not be less than 95 per cent. This insoluble matter is treated with H_2SO_4 and HF in usual manner, loss being considered as silica, SiO_2; the residue is fused with Na_2CO_3, taken up with water and HCl, evaporated to dryness, any SiO_2 (test for $BaSO_4$) filtered out and Al, Fe, Ca, and Mg determined as in gypsum. The filtrate from the insoluble matter (that is, the soluble portion) is evaporated to dryness, taken up with HCl and water, SiO_2 filtered out, ignited and weighed as usual. In filtrate determine Al, Fe, Ca, and Mg as usual. If it is desired to determine alkalies, work on a separate portion by the method of Mr. J. Lawrence Smith as in Bulletin No. 422, U. S. Geological Survey.

Iron in Small Amounts.—See "Method for Very Small Amounts of Iron."

CHINA CLAY AND ASBESTINE.

Moisture.—Determined as under silica.

Loss on Ignition.—Determined as under silica.

Qualitative tests to prove that the materials are as represented will generally suffice. However, a complete analysis may be made as follows:

Fuse 1 g. of the finely powdered sample in a platinum crucible with about 10 g. of Na_2CO_3 (requires ½ to 1 hour); cool, place in casserole, digest with hot water till mass disintegrates; acidify with HCl, remove crucible and lid, washing thoroughly. Evaporate to dryness on steam bath, take up with HCl and hot water, filter, wash with hot water till free from Cl; evaporate filtrate to dryness and treat as before, filtering on a separate paper. Burn

[1] For more refined methods of analysis, see Hillebrand, "The Analysis of Silicate and Carbonate Rocks," *Bulletin No. 422*, U. S. Geological Survey.

the two silica precipitates together in a platinum crucible, finally heating over Meker burner to constant weight; treat with H_2SO_4 and HF in usual manner, loss equals SiO_2. If sample contains $BaSO_4$, melt from fusion should be digested in hot water till completely disintegrated, the $BaCO_3$ filtered off and washed with hot water. The $BaCO_3$ and residue are dissolved in hot dilute HCl, the Ba precipitated with dilute H_2SO_4, and the $BaSO_4$ determined in usual manner. Filtrate from this $BaSO_4$ is added to first filtrate, acidified, evaporated for silica, etc., as described. The residue from SiO_2 is considered as Al_2O_3 and Fe_2O_3, the Al and Fe subsequently obtained being ignited in same crucible. In filtrate from SiO_2 make a double precipitation of Al and Fe with NH_4OH (having sufficient NH_4Cl present to hold all MgO in solution), ignite and weigh $Al_2O_3+Fe_2O_3$ ($TiO_2+P_2O_5$). This precipitate may be fused with $KHSO_4$, dissolved in dilute H_2SO_4, the iron reduced with H_2S (followed by CO_2) and titrated with $KMNO_4$. In united filtrates from Al and Fe, manganese may be precipitated with H_2S and NH_4OH and weighed in usual way. Expel H_2S and determine CaO and MgO as usual.

Determine alkalies on a separate portion by the method of Mr. J. Lawrence Smith.

Carbon Dioxide.—Determined by evolution method, weighing.

Soluble Sulfates.—Boil 1 g. with 20 cc. of HCl (1 : 1) and 100 cc. of water, filter, wash. Add NH_4OH till just alkaline, HCl till acid and precipitate with $BaCl_2$ in usual manner.

Asbestine is often treated with HCl as under silica, the soluble and insoluble portions being analyzed separately.

APPENDIX II.

ANALYSIS OF RED LEAD.[1]

Approximate formula, Pb_3O_4 (probably $PbO_2.2PbO$).

Apparent gravity and true specific gravity determined as per methods under white pigments.

Fineness.—Wash 10 g. with water through No. 21 silk bolting cloth, dry and weigh residue.

Moisture.—Dry 2 g. of the sample for 2 hours at 105° C. The loss in weight is considered as moisture.

Organic Color.—Boil 2 g. of the sample with 25 cc. of 95-per-cent ethyl alcohol, let settle, decant off the supernatant liquid; boil residue with water, decant as before and boil residue with very dilute NH_4OH. If either the alcohol, water or NH_4OH is colored, organic coloring matter is indicated.

Total Lead and Insoluble Matter.—Treat 1 g. of the sample with 15 cc. of HNO_3 (1 : 1) and sufficient hydrogen dioxide to dissolve all PbO_2 on warming. If any insoluble matter is present add 25 cc. of water, boil, filter and wash with hot water. Insoluble contains free SiO_2 and should be examined for $BaSO_4$ and silicates, if appreciable. To original solution or filtrate from insoluble, add 20 cc. of concentrated H_2SO_4 and evaporate to SO_3 fumes; cool, add 150 cc. of water and 150 cc. of 95-per-cent ethyl alcohol, let stand *cold* 2 hours, filter on a Gooch crucible, wash with 95-per-cent alcohol, dry at 105 to 110° C. and weigh as $PbSO_4$. Calculate to PbO. Red lead is rarely adulterated, but should sample contain soluble barium compounds, the $PbSO_4$ obtained above will contain $BaSO_4$. In this case, digest above precipitate with acid ammonium-acetate solution, filter off $BaSO_4$, wash, ignite and weigh $BaSO_4$. Calculate to BaO or $BaCO_3$. In filtrate, determine the lead as $PbSO_4$ or $PbCrO_4$. If sample contains significant amounts of calcium or magnesium, the HNO_3–H_2O_2 solution is boiled till all lead is converted into nitrate and then lead determined as $PbCrO_4$. If Ca and Mg are to be determined, separate lead as PbS and proceed as under basic sulfate of lead in presence of these metals.

Determination of Lead Peroxide (PbO_2) and True Red Lead (Pb_3O_4).—(Method of Diehl[2] modified by Topf[3]—not applicable when substances are present, other than oxides of lead, that liberate iodine under conditions given.)

Weigh 1 g. of finely ground sample into a 200-cc. Erlenmeyer flask, add a few drops of distilled water and rub the mixture to a smooth paste with a glass rod flattened on end. Mix in a small beaker 30 g. of c. p. "Tested Purity" crystallized sodium acetate, 2.4 g. of c. p. potassium iodide, 10 cc.

[1] This includes orange mineral.

[2] *Dingl. polyt. Jour.*, Vol. 246, p. 196.

[3] *Zeitschrift für analytische Chemie*, Vol. 26, p. 296.

of water and 10 cc. of 50-per-cent acetic acid; stir until all is liquid, warming gently; if necessary add 2 to 3 cc. of H_2O, cool to room temperature and pour into the flask containing the red lead. Rub with the glass rod until nearly all the red lead has been dissolved; add 30 cc. of water containing 5 or 6 g. of sodium acetate, and titrate at once with decinormal sodium thiosulphate, adding the latter rather slowly and keeping the liquid constantly in motion by whirling the flask. When the solution has become light yellow, rub any undissolved particles up with the rod until free iodine no longer forms, wash off rod, add the sodium-thiosulphate solution until *pale yellow*, add starch solution and titrate until colorless, add decinormal iodine solution until blue color is just restored and subtract the amount used from the volume of thiosulfate that had been added.

Calculation.—The iodine value of the sodium-thiosulfate solution multiplied by $0.94193 = PbO_2$; the iodine value multiplied by $2.69973 = Pb_3O_4$; the PbO_2 value multiplied by $2.86616 = Pb_3O_4$.

The Sodium-Thiosulfate Solution (decinormal).—Dissolve 24.83 g. of c. p. sodium thiosulfate, freshly pulverized and dried between filter paper, and dilute with water to 1 liter at the temperature at which the titrations are to be made. Solution best made with well-boiled H_2O free from CO_2, or let stand 8 to 14 days before standardizing. Standardize with pure, resublimed iodine, as described in Treadwell-Hall, "Analytical Chemistry," Vol. II, p. 602 (1910), and also against pure potassium iodate—the two methods of standardization should agree within 0.1 per cent on iodine value.

Starch Solution.—Two to three grams of potato starch are stirred up with 100 cc. of 1-per-cent salicylic-acid solution, and the mixture is boiled till starch is practically dissolved, then diluted to 1 liter,[1] or as per Lord.[2]

Zinc.—If in appreciable amount, determine in filtrate from total lead as per methods under zinc white, evaporating off the alcohol.

Water-Soluble.—Digest 10 g. of sample with 200 cc. of hot water on steam bath for 1 hour; filter on an 11-cm. S. & S. blue-ribbon paper and wash with hot water till no residue is left on evaporating a few drops of the washings. Evaporate filtrate to dryness on steam bath in a weighed dish, dry 30 minutes at 105° C., cool and weigh. Take up with water and if alkaline, titrate with 0.1 normal acid and methyl orange; calculate to Na_2CO_3. Another lot of water-soluble matter is tested for nitrates, nitrites, carbonates, sulfates, sodium and lead.

Total Silica.—Digest 5 g. of the sample in a covered casserole with 5 cc. of HCl and 15 cc. of HNO_3 (1 : 1). Evaporate to dryness to dehydrate. Cool, treat with hot water and HNO_3, boil, filter, wash with hot acid ammonium-acetate solution, then dilute HCl and finally hot water. Ignite and weigh as SiO_2. The residue may be treated with H_2SO_4 and HF in cases of doubt as to purity.

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[1] *Lead Peroxide.*—If sample contains an appreciable amount of nitrite (nitrate has no effect on method), leach out water-soluble matter as below, dry residue and determine PbO_2 as above, calculating to basis of original sample.

[2] "Notes on Metallurgical Analysis," p. 103 (1903).

Carbon Dioxide.—Determined by evolution method, using dilute HCl and stannous chloride.

Soluble Sulfate.—Determined as under basic sulfate of lead.

Iron Oxide.—Determined by Schaeffer's[1] modification of Thomson's colorimetric method; or, in a large beaker, treat 20 g. of the sample with 20 cc. of water, 20 cc. of HNO_3 (sp. gr. 1.4) and 3 cc. of formaldehyde solution. Warm till all PbO_2 is dissolved, dilute with water, warm, filter off insoluble and wash with hot water. Ignite filter and insoluble, evaporate with H_2SO_4 and hydrofluoric acid. To filtrate from insoluble add 14 cc. of H_2SO_4 (1 : 1), filter off $PbSO_4$, wash. Residue from HF and H_2SO_4 is dissolved in H_2SO_4 and added to filtrate from $PbSO_4$; dilute to 500 cc. and determine Fe colorimetrically in an aliquot, using same amounts of HNO_3, H_2SO_4 and formaldehyde in comparison solution.[2] Calculate to Fe_2O_3.

RESULTS OF ANALYSIS OF DRY RED LEAD.

The analysts so far reporting are as follows:

1. W. A. Cowan for G. W. Thompson, Chief Chemist, National Lead Company, 129 York St., Brooklyn, N. Y.

2. H. C. Mougey and R. Greenawalt for D. A. Kohr, Supt., Lowe Bros. Co., Dayton, O.

3. H. A. Gardner, Assistant Director, Institute of Industrial Research, Washington, D. C.

4. J. A. Schaeffer, Chief Chemist, Picher Lead Co., Joplin, Mo.

5. C. P. Van Gundy, Chief Chemist, Baltimore & Ohio Railroad Co., Baltimore, Md.

6. L. P. Nemzek, Chemist, John Lucas & Co., Gibbsboro, N. J.

7. E. F. Deysher for F. W. Smither, Assistant Chemist, Bureau of Chemistry, Washington, D. C.

8. G. F. Hough for P. H. Walker, Chief of Contracts Laboratory, Bureau of Chemistry, Washington, D. C.

9. A. N. Finn and F. A. Wertz for S. S. Voorhees, Engineer-Chemist, Bureau of Standards, Washington, D. C.

10. F. W. Smither, Bureau of Chemistry, Washington, D. C.

11. E. C. Holton, Chief Chemist, The Sherwin-Williams Co., Cleveland, O.

12. George N. Prentiss, Chemist, Chicago, Milwaukee & St. Paul Railway Co., Milwaukee, Wis.

13. F. P. Ingalls, Chemist, John W. Masury & Son, New York, N. Y.

14. H. H. Graver, Chief Chemist, Pittsburgh Testing Laboratory, Pittsburgh, Pa.

15. J. H. Gibboney, Chief Chemist, Norfolk & Western Railway Co., Roanoke, Va.

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[1] *Journal of Industrial and Engineering Chemistry*, Vol. 4, p. 659 (1912).

[2] "Chemisch-technische Untersuchungs-Methoden," Lunge-Berl, Bd. 2, S. 95, 6th Ed.

TABLE I.—ANALYSES OF DRY RED LEAD.

Analyst No.	Thiosulfate Standardized against $K_2Cr_2O_7$ as per Bulletin No. 107, Bureau of Chemistry.				Thiosulfate Standardized against Resublimed Iodine.			
	PbO_2, per cent.		Pb_3O_4, per cent.		PbO_2, per cent.		Pb_3O_4, per cent.	
	Sample No. 1.	Sample No. 2.	Sample No. 1.	Sample No. 2.	Sample No. 1.	Sample No. 2.	Sample No. 1.	Sample No. 2.
1	28.90	33.72	82.83	96.66	29.32	34.20	84.03	98.03
2	28.91	33.58	82.86	96.24	29.07	33.73	83.31	96.67
	29.01	33.66	83.15	96.48	.....	.....	.....	.....
	28.94	33.55	82.93	96.16	.....	.....	.....	.....
Average	28.95	33.60	82.98	96.29				
3	28.83	33.49	82.63	96.00	28.83	33.49	82.63	96.00
4	29.21	34.21	83.71	98.04	28.87	33.85	82.75	97.01
5	.....	.....	.....	.....	28.98	33.73	83.07	96.68
6	28.88	33.64	82.79	96.42	28.96	33.72	83.00	96.65
	28.87	33.50	82.75	96.03	.....	.....	.....	.....
	28.90	33.62	82.83	96.36	.....	.....	.....	.....
Average	28.88	33.59	82.80	96.27	.....	.....	.....	.....
7	28.84	33.66	82.66	96.47	.....	.....	.....	.....
	28.84	33.66	82.66	96.47	.....	.....	.....	.....
Average	28.84	33.66	82.66	96.47	.....	.....	.....	.....
8	28.80	33.60	82.55	96.30	.....	.....	.....	.....
9	29.04	33.86	83.23	97.05	29.13	33.96	83.48	97.34
	29.10	33.90	83.40	97.15	29.19	34.00	83.65	97.44
	29.07	.....	83.33	.....	29.16	.....	83.58	.....
	29.07	.....	83.33	.....	29.16	.....	83.58	.....
Average	29.07	33.88	83.32	97.10	29.16	33.98	83.58	97.39
10	28.97	33.68	83.03	96.52	29.11	33.92	83.44	97.22
	28.97	33.75	83.03	96.73	29.11	33.97	83.44	97.36
	28.92	33.72	82.89	96.64	29.11	33.97	83.44	97.36
	28.97	33.55	83.03	96.32	29.11	33.97	83.44	97.36
Average	28.96	33.70	82.98	96.60	29.11	33.96	83.44	97.34
11	28.97	33.82	83.05	96.94	.....	.....	.....	.....
12	29.13	33.93	83.50	97.25	29.16	33.96	83.59	97.35
	29.13	33.93	83.50	97.25	29.16	33.96	83.59	97.35
Average	29.13	33.93	83.50	97.25	29.16	33.96	83.59	97.35
13	29.01	33.95	83.15	97.32	29.18	34.16	83.65	97.90
	28.95	34.02	82.97	97.52	29.12	.....	83.47	.....
Average	28.98	33.98	83.06	97.42	29.15	.....	83.56	.....
14	29.06	33.73	83.29	96.68	29.22	33.91	83.77	97.22
15	.....	.....	.....	.....	.....	.....	83.23	97.31
General Average			83.06	96.77			83.33	97.13
Maximum			83.71	98.04			84.03	98.03
Minimum			82.63	96.30			82.63	96.00
General Average			82.97[a]	96.66[c]			83.405	.....

[a] No. 4 omitted from general average.

[b] Nos. 1, 3 and 4 omitted from general average.

[c] Nos. 3, 4 and 13 omitted from general average.

REMARKS OF ANALYSTS

No. 1. Value of thiosulfate solution:
By dichromate method, 1 cc. = 0.01235 g. iodine.
By resublimed iodine, 1 cc. = 0.01252 g. iodine.
By arsenious acid, 1 cc. = 0.01250 g. iodine.
By copper, 1 cc. = 0.01249 g. iodine.

No. 2. Sample No. 2 by Bunsen distillation method gave 33.59 and 33.65 per cent of PbO_2, equivalent to 96.27 and 96.44 per cent of Pb_3O_4, based on dichromate standardization. Iodine standardization gives a factor 1.004 times as high as the dichromate method.

No. 3. By the Schaeffer HNO_3–H_2O_2–$KMnO_4$ method, sample No. 1 showed 84.94 per cent of Pb_3O_4; sample No. 2 showed 97.61 per cent of Pb_3O_4.

No. 4. By HNO_3–H_2O_2–$KMnO_4$ method, sample No. 1 showed 83.64 per cent of Pb_3O_4; sample No. 2 showed 97.53 per cent of Pb_3O_4.

No. 5. Sample No. 1 showed 82.09 per cent of Pb_3O_4 and sample No. 2 showed 95.59 per cent of Pb_3O_4 by weighing thiosulfate and checking against N/10 $KMnO_4$. On standardizing against iodine the value = 0.013024; against KIO_3 0.013018; against $KMnO_4$ 0.012994 and 0.012957; $KMnO_4$ against sodium oxalate 0.005257, Fe = 0.011922 iodine.

No. 9. Average of six determinations on standardizing against iodine gave values ranging from 0.012419 to 0.012448. Against dichromate the average = 0.012396, ranging from 0.012377 to 0.012419.

No. 10. The percentages of Pb_3O_4 based on different methods of standardizing the thiosulfate solution are as follows:

	No. 1.	No. 2.
Potassium Iodate	83.44	97.34
Potassium Acid Iodate	83.44	97.34
Arsenious Acid	83.57	97.49
Copper	83.72	97.66
Potassium Dichromate, by weighing each portion used	83.18	97.03
$K_2Cr_2O_7$—50 cc. of N/10 solution with HCl	83.25	97.12

No. 12. $K_2Cr_2O_7$ solution standardized against ammonium ferrous sulfate.

No. 13. The percentages of Pb_3O_4 based on different methods of standardizing the thiosulfate solution as follows:

	No. 1.	No. 2.
$K_2Cr_2O_7$ and H_2SO_4[1]	83.44	97.66
Iodine weighed from Stock	83.66	97.92
Copper	83.72	97.99
Copper with double quantity of KI	83.32	97.52

[1] Seubert and Henke, *Zeitschrift für angew. Chemie*, p. 1147 (1900).

REPORT OF SUB-COMMITTEE X ON INSPECTION OF WHITE-PAINT TEST FENCE AT WASHINGTON, D. C.

The following detailed statements of the inspections of the test fence show the condition of the panels at the dates when inspections were made.

The purpose of the inspection of January 29, 1913, was to record the condition of the panels at the beginning of the test, as it was not expected that any material change would have occurred in the few months that the paints had been exposed. An inspection was made June 5, 1913, when notes were made regarding the condition at that time; but it was decided at the meeting of the sub-committee held April 16, 1914, that the information obtained was not sufficient to warrant publication in the annual report of Committee D-1.

The report of the inspection made December 4, 1913, records the conditions of the panels after some fifteen months' exposure and is of sufficient importance to warrant publication. This inspection was made by Messrs. Voorhees, Macnichol, Gardner and Rogers, of the sub-committee, and Messrs. P. H. Walker, Smither and Boughton, of Committee D-1. The photographs accompanying this report (Figs. 1–26) were made by Mr. Beeson, one of the photographers for the Department of Agriculture. These photographs show two views of the east side of the fence, one from the south end and one from the north end, and also detailed views of the panels in groups of five. It is hoped that even more detailed photographs may be made prior to the annual meeting which will show the actual condition of each panel.

In connection with the tabulated statement of the inspection of December 4, 1913, the following explanation and brief summary should be considered:

A very noticeable difference in the color of the various panels was evident on casual inspection, as is shown by the general photographs of the fence, and this difference is brought out more in detail by an inspection of the photographs of each

FIG. 1.—East Side of Fence from South End.

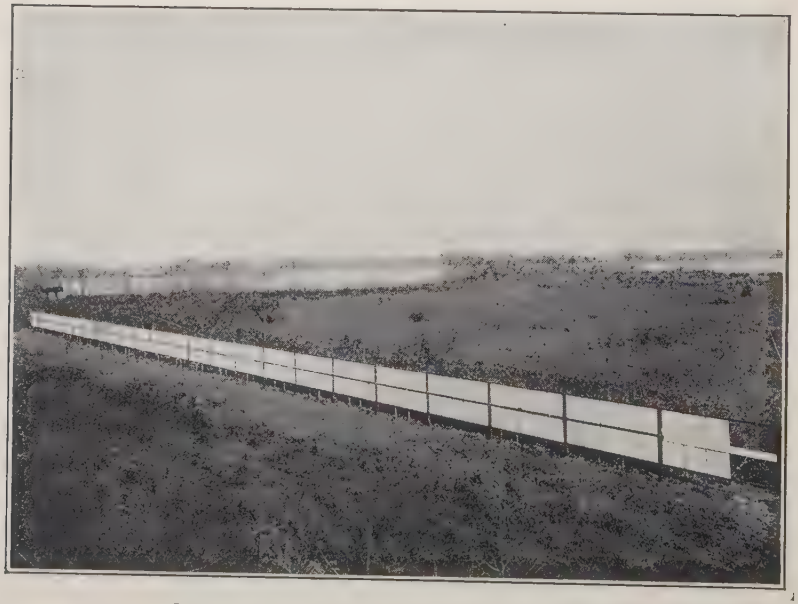


FIG. 2.—East Side of Fence from North End.

section, which includes 5 panels in duplicate. To show the actual color and appearance of each panel a freshly painted white-pine strip was placed along the bottom of the upper row of panels as a basis for comparison. The same painted strip is shown in each sectional photograph.

The checking, cracking, etc., reported, in no case appeared to extend through the three coats of paint but were apparently surface actions.

In considering the test it is undoubtedly more rational to classify the composite pigments on a volume rather than a weight basis, as they were designed on that basis.

Results of Inspection.

Primary Pigments.—Panels Nos. 101 to 103, inclusive, consist of the three types of basic-carbonate white lead. They show more or less checking which does not extend through all coats; they also have picked up some dirt.

Panels Nos. 104 and 105 are zinc oxide. They show extremely fine surface checking and are very clean.

Panel No. 106 is basic-sulfate white lead. It shows very fine surface checking and is very dirty.

Panel No. 107, zinc-lead white, shows no checking and surface is very clean.

Binary Composition.—Panels Nos. 201 to 208, inclusive, consist of 80 per cent of basic-carbonate white lead and 20 per cent of one of the following pigments in the order named: zinc oxide, basic-sulfate white lead, silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. While an effort has been made to differentiate between these panels, the differences are slight except in No. 201, which is clean and white with slight checking, in marked contrast to the others which are decidedly dirty; No. 208 shows fine checking and has a medium clean surface.

Panels Nos. 209 to 216, inclusive, consist of 50 per cent of basic lead carbonate and 50 per cent of one of the other pigments named in the group of Nos. 201 to 208, inclusive. Here again the mixture of basic-carbonate white lead and zinc oxide shows but fine checking and the surface is clean. Panel No. 210,

composed of basic-carbonate and basic-sulfate white lead, shows no checking with a medium clean surface, while the others showed a tendency to pick up dirt to a greater or less degree.

Panels Nos. 217 to 219, inclusive, consist of 60 per cent of basic-carbonate white lead and 40 per cent of French-Process zinc oxide, American-Process zinc oxide and basic-sulfate white lead. The two panels made up with white lead and the two zinc oxides show very fine checking but are white and clean, while the combination with basic-carbonate white lead and basic-sulfate white lead shows marked checking and is rather dirty.

No formula is given for panel No. 220.

Panels Nos. 221 to 227, inclusive, consist of 50 per cent of American-Process zinc oxide and 50 per cent of one of the following pigments in the order named: basic-sulfate white lead, silica, asbestine, China clay, calcium sulfate, calcium carbonate, and barium sulfate. This series is characterized by a clean, white surface and in general by an absence of checking.

Panels Nos. 228 to 233, inclusive, consist of 50 per cent of basic-sulfate white lead, and 50 per cent of one of the following pigments in the order named: silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. They are characterized by a dirty surface and a marked tendency to check.

Panels Nos. 234 and 235 consist of 60 per cent of French and American-Process zinc oxide and 40 per cent basic-carbonate white lead. They are very clean but show some fine checking.

Ternary Composition.—Panels Nos. 301 to 307, inclusive, consist of $33\frac{1}{3}$ per cent of basic-carbonate white lead, $33\frac{1}{3}$ per cent of zinc oxide and $33\frac{1}{3}$ per cent of one of the following pigments in the order named: basic-sulfate white lead, silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. This group is characterized by the absence of checking or fine checking and has a clean, white surface.

Panels Nos. 308 to 314, inclusive, consist of 50 per cent of basic-carbonate white lead, 25 per cent of zinc oxide and 25 per cent of one of the pigments named in the group Nos. 301 to 307, inclusive. These panels are in the same general condition as the group of Nos. 301 to 307, inclusive.

Panels Nos. 315 to 321, inclusive, consist of 25 per cent of

basic-carbonate white lead, 50 per cent of zinc oxide and 25 per cent of one of the pigments named above. This group shows no checking or very fine checking with a very clean, white surface.

Panels Nos. 322 to 328, inclusive, consist of 25 per cent of basic-carbonate white lead, 25 per cent zinc oxide and 50 per cent of one of the pigments named above. Their condition is practically identical with group of Nos. 315 to 321, inclusive.

Panels Nos. 329 to 334, inclusive, consist of $33\frac{1}{3}$ per cent of basic-sulfate white lead, $33\frac{1}{3}$ per cent of zinc oxide and $33\frac{1}{3}$ per cent of one of the following pigments in the order named: silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. This group shows no checking and a very clean, white surface, except panel No. 333, which shows small amount of dirt.

Panels Nos. 335 to 340, inclusive, consist of 50 per cent of basic-sulfate white lead, 25 per cent of zinc oxide and 25 per cent of one of the pigments named in the group of Nos. 329 to 334, inclusive, and their condition is practically the same as that group.

Panels Nos. 341 to 346, inclusive, consist of 25 per cent of basic-sulfate white lead, 50 per cent of zinc oxide and 25 per cent of one of the pigments named in the group of Nos. 329 to 334, inclusive, and their condition is practically the same as that group.

Panels Nos. 347 to 352, inclusive, consist of $33\frac{1}{3}$ per cent of basic-carbonate white lead, $33\frac{1}{3}$ per cent of basic-sulfate white lead and $33\frac{1}{3}$ per cent of one of the following pigments in the order named: silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. They show more or less checking with dirty surface.

Panels Nos. 353 to 358, inclusive, consist of 50 per cent of basic-carbonate white lead, 25 per cent of basic-sulfate white lead, and 25 per cent of one of the pigments named in group of Nos. 347 to 352, inclusive, and their condition is about the same as that group.

Panels Nos. 359 to 364, inclusive, consist of 25 per cent of basic-carbonate white lead, 50 per cent basic-sulfate white lead and 25 per cent of one of the pigments named in group of Nos. 347 to 352, inclusive. Their condition is about the same as that group.

Panels Nos. 365 to 370, inclusive, consist of 25 per cent of basic-carbonate white lead, 25 per cent of basic-sulfate white lead and 50 per cent of one of the pigments named in group of Nos. 347 to 352, inclusive, and their condition is practically the same as that group.

Quaternary Composition.—Panels Nos. 401 to 406, inclusive, consist of 25 per cent of basic-carbonate white lead, 25 per cent of zinc oxide, 25 per cent of basic-sulfate white lead and 25 per cent of one of the following pigments in the order named: silica, asbestine, China clay, calcium carbonate, calcium sulfate and barium sulfate. The condition of this group is characterized by an absence of checking or cracking and a clean, white surface.

SUMMARY.

While conclusions are not warranted from a series of incomplete exposure tests such as these, certain indications are very evident from an inspection of these panels, which have been exposed to normal atmospheric conditions for about 15 months, especially when their conditions are compared on the basis of their volume composition.

On this basis none of the paints composed of a single primary pigment are equal to the paints made up with composite pigments except zinc-lead white, which is actually a composite pigment.

In the binary and ternary series the groups containing zinc oxide show less cracking and checking and a whiter and cleaner surface than those groups in which it is absent.

The present conditions also seem to warrant the statement that the quaternary series is in the best condition of any of the panels included in the test.

It should also be stated that the hiding power was not considered in this series of tests.

The results of the inspections made January 29, 1913, and December 4, 1913, together with the photographs of the panels taken at the latter date, are contained in the appendix to this report.

Respectfully submitted on behalf of the sub-committee,

S. S. VOORHEES,
Chairman.

APPENDIX I.

RESULTS OF INSPECTION.

Inspection Made January 29, 1913.

The inspection was made by Messrs. Voorhees, Gibboney, Van Gundy, Polk, Macnichol and Gardner, of the sub-committee, in order to record the abnormal conditions present on certain panels, due either to the improper preparations of the paint, the non-drying of the paint, or other factors. It is the idea of the sub-committee to have this report on file so that the conditions present may be taken into consideration when making official inspections of the fence.

In the following report there is described each of the four panels representing each formula. For instance, panel A of any formula is the upper panel on the west side of the fence, panel B is the lower panel on the west side of the fence, panel C is the upper panel on the east side of the fence, and panel D is the lower panel on the east side of the fence.

A dash placed after any panel indicates that the panel is in fairly good condition and that no abnormalities are present. Wherever abnormalities are present some qualifying or descriptive remark is placed after the panel number.

Primary Pigments.

Panel No.

101 A Slight dark streaking at bottom of panel.
B Considerable dark streaking on left border of panel.
C Uniform streaking, more noticeable on left-hand side of panel.
D Uniform streaking, but noticeable on the left-hand panels.

102 A .....
B Streaking at upper portion of panel only.
C Uniformly spotted with dirt. Streaking on the right panel all the way across at the top.
D Cobwebbed on the right-hand panel. Spotted with dirt on the other two panels.

PANEL NO.

103 A Has a few rough marks at left-hand side, like handling marks. Middle board warped.
B Considerable black specks noticeable on upper portion of panel.
C, D Same as A and B.

104 A Slight streaking at bottom of middle board only. Middle board warped.
B Extremely bad slipping of top coat of paint all over surface, exposing under coat.
C Slight slipping of paint on all three panels.
D Panel 2 slightly streaked and the other very badly.
A, B, C, D Very transparent, lacking hiding properties.

105 A, B, C, D Somewhat transparent with bluish tint. B Contains several excrescences, yellow in color, resembling tobacco juice.

106 A Abrasions on upper left-hand corner and streaking of paint on right-hand board. Paint transparent. Middle board warped.
B Some streaking of paint on middle part of board. Paint transparent.
C Brush marks show very clearly, the color of the wood in the middle board showing up distinctly as against the color of the outside boards. Same as A and B.
D Same as A and B.

107 A Considerable short streaks like laps in brush marks.
B Very sandy, rough surface.
C .....
D Slightly sandy; tendency for paint to run on middle board.

BINARY COMPOSITION.

201 A, B, C, D Paint a little sandy and lacks some hiding power; otherwise all right.

202 A Dirty, spotted surface especially at bottom of panel; somewhat transparent.
B Similar to A, except more streaks of dirt present.
C, D Very dirty all over.

203 A, B Very much streaked, dark surface, especially at bottom and considerable running of paint is shown. Middle board of A warped.
C Dark and streaked, especially left-hand side of panel.
D Streaked and dirty all over.

204 A Very sandy appearance with darkness pronounced at bottom of panel; outside panels transparent.
B Similar in appearance to A and contains upon the upper surface a very broad reproduction of a cobweb; pronounced streaking on middle board.
C Cobwebbed, dirty all over, specked.
D Dirty and specked all over.

205 A Badly warped panel, especially in middle. Middle board streaked with two long lateral lines of dirt; outside boards also very dirty and specked, with some streaking; brush marks.

Panel No.

205 B Streaking of paint indicative of brush marks; under coat showing in some places.
C Streaked and specked, particularly the top.
D Badly streaked.
206 A Left-hand board badly streaked, some brush marks.
B Considerable dark streaking on left-hand side boards, gritty surface, rough on both panels A and B.
C Specked.
D Streaked and specked.
207 A, B Middle board warped, some streaking.
C Specked; abrasion on right-hand side panel.
D Specked all over; some slipping of paint.
208 A Some streaking on right-hand side panels and very rough, gritty surface.
B Rough, gritty surface.
C Specked and streaked and has a lot of marks resembling soot.
D Specked and streaked.
209 A Some transparency.
B Dark streaks over surface.
C, D Streaky.
210 A Red handling marks all over right-hand board.
B Rather gritty surface; sappy excrescences on right-hand board.
C Left-hand board has shipping marks, abrasions.
D .....
211 A Panel streaked with dirt all over surface; cobwebbed everywhere. Dark band at bottom of panel. Considerable abrasion marks.
B Same as A except right-hand board, which is very white but transparent.
C All badly streaked and transparent.
D Two right-hand side boards clear and white but left-hand board very black, dirty and streaked.
212 A Boards black, streaked and spotted all over, especially at bottom.
B Worse than A.
C, D Same as A and B, except that C is still worse.
213 A, B Streaked, cobwebbed and spotted all over surface.
C, D About the same as A and B.
214 A, B, C Considerable darkening in streaks.
D Cobwebs on upper portion of panel.
215 A Considerable dark streaking with handling marks on left-hand side board.
B About the same as A; very rough surface, birds' feathers on middle board.
C, D Same as A and B.
216 A Panel has a very yellow coat with long black streaks.
B Same as A with pronounced long black streak on middle board.
C Panel has a very yellow cast with long black streaks.
D Same as A with pronounced long black streak on middle board.

PANEL NO.

217 A, B, C, D .....

218 A, B, C, D Some slight brush marks.

219 A Panel streaked at the lower portion; has 40 or 50 mosquitoes embedded in paint with streaking of paint from each mosquito.
B Right-hand board badly streaked.
C Left-hand board very dirty.
D Streaky.

220 A, B, C, D No formula given in chart. Panels in bad condition.

221 A Dirty and spotted from handling; rather transparent.
B Left-hand board very sandy and streaked; middle board especially transparent.
C A little transparent and marks from handling.
D Slightly transparent.

222 A Left and right-hand sides of boards split in middle.
B .....
C Split and handling marks.
D Slightly transparent.

223 A Very transparent.
B, C Very transparent showing color of wood through paint.
D Same as B, C. Brush marks apparent.

224 A, B, C, D Very transparent, with brush marks very apparent.

225 A, B Quite transparent, showing color of wood through paint; also some brush marks.
C Left-hand panel dirty.
D No remarks, except transparency.

226 A, B, C, D Transparent, sandy and some brush marks.

227 A, B Quite transparent, showing color of wood through paint; also brush marks apparent.
C, D Quite transparent; brush marks apparent.

228 A, B Handling marks; slight gritty surface.
C Rather mildewed surface.
D Slight transparency.

229 A Brush marks at bottom of panel very apparent.
B Right-hand board very transparent with brush marks.
C, D Transparent and brush marks.

230 A Some handling marks; brush marks very apparent.
B Streaked all over surface with pronounced brush marks. Right-hand board very gritty and streaked.
C Brush marks; middle board streaked down middle.
D Brush marks.

231 A Right-hand board badly streaked down one side.
B Streaks pronounced on middle board.
C Brush marks at bottom; middle board streaked.
D Slight transparency with brush marks.

232 A Some handling marks; sandy surface at bottom.
B Slight streaking, very sandy surface.

Panel No.

232 C Mildewed surface.
D Slight transparency.
233 A Middle board slightly transparent.
B Slight sandy surface on middle board.
C Slightly streaked; left-hand panel cobwebbed at top.
D .....
234 A, B, C, D .....
235 A Slight handling mark on right-hand panel.
B .....
C Dirty, mottled appearance.
D Mottled.

Ternary Composition.

301 A Middle board streaked in middle.
B, C .....
D Middle panel dirty at top; right-hand panel dirty on right side.
302 A Slight handling marks.
B, C, D .....
303 A Brush marks at bottom of panel.
B Slight handling marks.
C .....
D Quite transparent.
304 A Some slight transparency.
B Right-hand board shows pronounced transparency
C .....
D Dirty.
305 A Transparency of paint shown plainly.
B Same as A, especially on left-hand side board where transparency is pronounced.
C, D .....
306 A, B, C, D .....
307 A Transparency of bluish cast, grayish-blue tint.
B Handling marks on right-hand board; slight grayish tint.
C Slight transparency on two right-hand side boards.
D .....
308 A Slight transparency.
B Very transparent, surface streaked with brush marks.
C, D .....
309 A, B, C, D .....
310 A Considerable handling marks and rather dirty.
B Few handling marks with slight transparency of surface.
C Black streaks
D .....
311 A Sandy appearance at bottom.
B Transparent surface and cobwebbed effect.
C Scratch on middle board.
D Scar on left board.

PANEL NO.

312 A, B, C, D .....
313 A Very sandy surface.
B Sandy surface on left-hand board.
C, D .....
314 A, B, C, D .....
315 A, B Slight transparency.
C, D Handling marks.
316 A, B Slight transparency.
C, D Handling marks on middle panel.
317 A Streaky, especially on right-hand board.
B .....
C Handling marks; red paint on middle panel.
D .....
318 A, B .....
C Handling marks on left-hand panels.
D .....
319 A, B, C, D .....
320 A, B .....
C, D Little sandy.
321 A Upper left-hand board spotted; bluish transparency.
B Bluish transparency.
C All right, except slight transparency.
D .....
322 A Some handling marks; grayish-blue tone.
B .....
C Handling marks on left-hand board, otherwise all right.
D .....
323 A, B Grayish-blue tone.
C .....
D Streaky on left-hand panel.
324 A Transparency apparent, especially on middle board.
B .....
C Middle panel scarred; right-hand panel streaked.
D .....
325 A, B, C, D Slight transparency.
326 A Right-hand board streaked.
B, C, D .....
327 A, B, C, D Slightly bluish casts on all four panels.
328 A Handling marks; slightly bluish cast.
B Slightly bluish cast.
C, D .....
329 A Slight transparency.
B Bluish cast.
C Left-hand panel streaked, slightly transparent.
D .....

Panel No.

330 A Slightly transparent.
B Slightly transparent, especially on right-hand board.
C Left-hand board transparent.
D Slight transparency.

331 A, B, C, D Transparency apparent, bluish tone especially along edge of boards.

332 A, B, C, D Slight transparency.

333 A Very transparent showing streaks of wood through paint.
B Same as A, with lots of handling marks on middle board.
C, D Very transparent.

334 A, B Very slight transparency.
C, D Slight transparency.

335 A, B Very slight transparency.
C, D Slight transparency.

336 A Handling marks; transparency shown.
B Transparency shown.
C, D Slightly transparent.

337 A, B, C, D Slight transparency.

338 A Slight transparency, hammer marks on lower left-hand part of panel.
B Slight transparency, hammer marks.
C, D Blue streaks.

339 A Transparent; streaks.
B, C, D Transparency shown.

340 A, B Very slight transparency.
C Slight transparency.
D Has scar on left-hand panel.

341 A, B, C, D .....

342 A, B Slight transparency.
C, D .....

343 A, B, C, D Slight transparency.

344 A Slightly transparent.
B Slightly transparent, slight creeping on outside boards.
C, D .....

345 A, B Slightly transparent.
C .....
D Middle board blue streaked, due to transparency.

346 A, B Quite transparent.
C Slightly transparent.
D .....

347 A, B, C, D .....

348 A Very streaky at lower part of panel with transparency
B Outside boards very transparent and streaky.
C, D Dirty and sandy.

349 A, B Spotted with dirty appearance all over surface.
C Spotted, dirty surface.
D Some cobwebs.

PANEL NO.

350 A, B Spotted, dirty surface, streaking shown.
C, D Dirty and streaky.
351 A Spotted and dirty, especially at bottom.
B Spotted and somewhat slightly streaked.
C, D Streaked and spotted.
352 A, B Spotted and streaked rather badly.
C, D Badly streaked and dirty.
353 A, B, C, D Streaked and spotted badly.
354 A, B, C, D Streaked and spotted badly.
355 A, B, C Streaked and spotted badly with very sandy surface.
D Sandy surface.
356 A, B Spotted; dark spots all over panel.
C, D Very dirty and streaked, sandy surface.
357 A, B Dark spots and streaks all over surface; sandy surface.
C, D Spotted and dirty; sandy.
358 A Dark surface at bottom, rather transparent.
B Transparency and streaking.
C, D Spotted and dirty.
359 A Rather dirty surface with slight spotting.
B Very badly streaked.
C Streaked and dirty.
D Very badly streaked and dirty.
360 A Spotted surface.
B, C, D Very badly streaked.
361 A Slightly spotted surface.
B Very badly streaked and spotted.
C, D Streaked and slightly spotted.
362 A Dark at bottom of panel.
B Panel streaked; right-hand board very badly mottled.
C Black streaks on all three boards.
D Middle and right-hand board badly streaked.
363 A Middle board streaked.
B Some handling marks; right-hand board badly streaked
C Streaky, cobwebs at top.
D Slightly streaked.
364 A Slight darkness at bottom of panel.
B Considerable transparency.
C Badly streaked.
D Very badly streaked.
365 A, B, C, D Spotted and very dirty at bottom.
366 A Left-hand panel badly streaked; balance of panel spotted
B Badly spotted surface.
C Some handling marks and abrasions.
D Badly spotted.
367 A, B, C, D Spotted surface.

PANEL NO.

368 A, B, C, D Spotted surface.

369 A, B, C, D Spotted surface. The spotting is a little worse than on panel No. 368.

370 A .....

B Handling marks; slight transparency.

C Streaks on middle panel; right-hand panel spotted.

D .....

QUATERNARY COMPOSITION.

401 A .....

B Handling marks; very slight transparency on both panels.

C, D .....

402 A, B, C, D Slight transparency.

403 A, B, C .....

D Streaking on middle board.

404 A, C .....

B, D Slight transparency.

405 A, B, C, D Slight transparency.

406 A, B, C, D Slight transparency.

ADDITIONAL COMMENTS

Panels Nos. 204 to 213, inclusive, buckled and strips reduced in size.

Panels Nos. 220 and 222 split on upper portion and left-hand panel respectively.

Panels Nos. 219 to 223, inclusive, Nos. 314 to 323, inclusive, Nos. 329 to 338, inclusive, Nos. 344 to 348, inclusive, buckled and strips reduced in size.

Panels Nos. 349 to 353, inclusive, continued buckling in spite of strips having been reduced.

Panels Nos. 359 to 403, inclusive, buckled and strips reduced in size.

INSPECTION OF EAST SIDE OF FENCE MADE DECEMBER 4, 1913.

PRIMARY COMPOSITION.

PANEL NO.

101 Considerable checking of final coat; considerable dirt on surface.

102 Uniform checking; some dirt but not so dirty as No. 101.

103 Extremely fine checking; some dirt.

104, 105 Extremely fine cracking; very clean.

106 Very light checking; very dirty.

107 No checking apparent; very clean.

BINARY COMPOSITION.

201 Extremely fine checking; very clean.

202, 203 Uniform checking; quite dirty.

PANEL NO.

204 Considerable fine checking; quite dirty.
205, 206 Very fine checking; rather dirty.
207 Fine checking; somewhat dirty.
208 Fine checking; medium clean surface.
209 Very fine checking; clean surface.
210 No checking; medium clean surface.
211 Slight checking; rather dirty.
212 Some fine checking; quite dirty.
213 Fine checking; rather dirty.
214, 215 Considerable checking; rather dirty.
216 No checking; somewhat dirty.
217, 218 Extremely fine checking; very clean.
219 Checking; rather dirty.
220 Eliminated from test.
221 Extremely fine checking; very clean.
222 to 224 No checking; very clean.
225 Extremely fine checking; very clean. One board of lower panel is out of place.
226, 227 No checking; very clean.
228, 229 Considerable checking; dirty.
230 Slight checking; very dirty.
231 Checking; very dirty. Lower panel has apparently been wiped off.
232 Very slight checking; very dirty.
233 Checking; very dirty.
234, 235—Very fine checking; very clean.

TERNARY COMPOSITION.

301, 302 Extremely fine checking; very clean.
303, 304 No checking; very clean.
305 to 307 Fine checking; very clean.
308 to 311 No checking; very clean.
312, 313 Extremely fine checking; very clean.
314 No checking; very clean.
315 to 317—Extremely fine checking; very clean.
318 No checking; very clean.
319 Extremely fine checking; very clean.
320, 321 No checking; very clean.
322 Extremely fine checking; very clean.
323 No checking; very clean.
324 No checking; some dirt.
325 No checking; very clean.
326 Extremely fine checking; very clean.
327 to 332 No checking; very clean.
333 No checking; small amount of dirt.
334 to 346 No checking; very clean.
347 Very slight checking; quite dirty.

Panel No.

348 Some checking; quite dirty.
349 to 353 Heavy checking; very dirty.[1]
354 to 368 Considerable checking; quite dirty.
369 Considerable checking; extremely dirty.
370 Considerable checking; dirty.

Quaternary Composition.

401 No checking; very clean.
403 to 406 No checking; very clean.

A brief examination of the west side of the fence was made and conditions and relative appearances were practically the same as on the east side of the fence reported above.

[1] These panels were blown down, and after being on the ground for some time, were again placed on the fence.

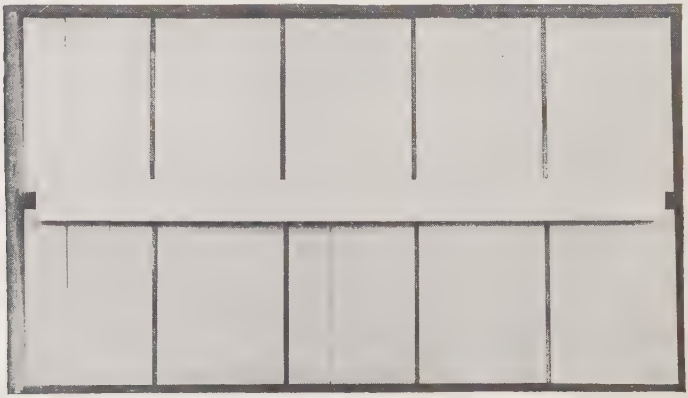


FIG. 3.

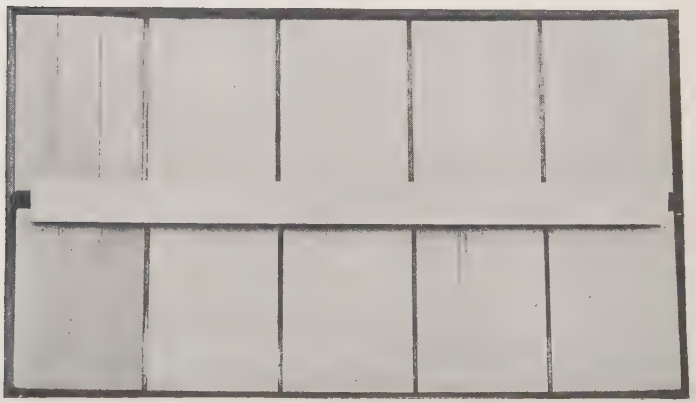


FIG. 4.

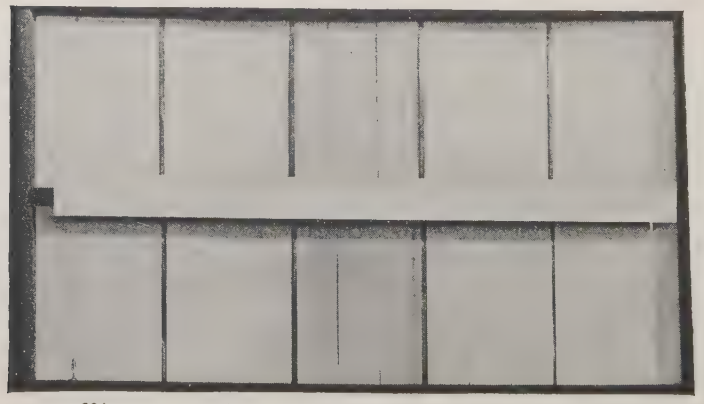


FIG. 5.

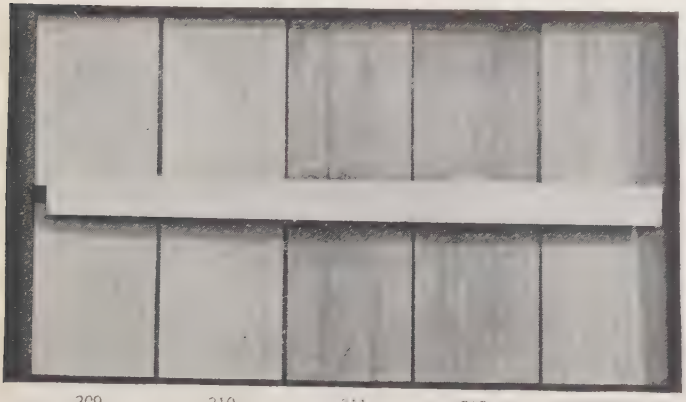


Fig. 6.

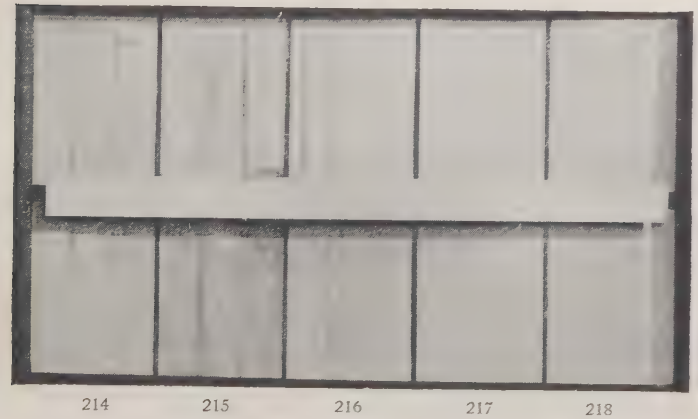


Fig. 7.

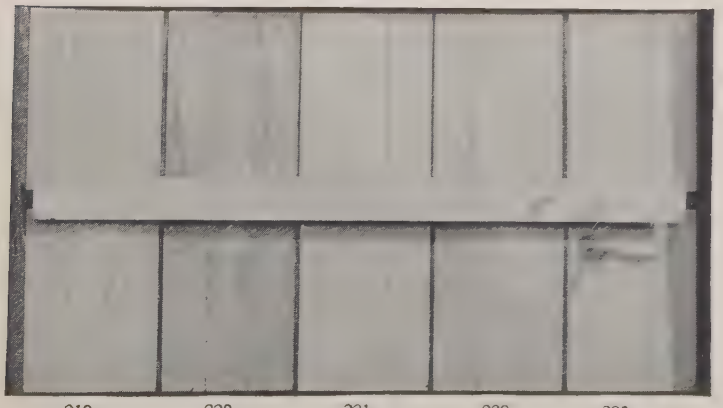


Fig. 8.

FIG. 9.

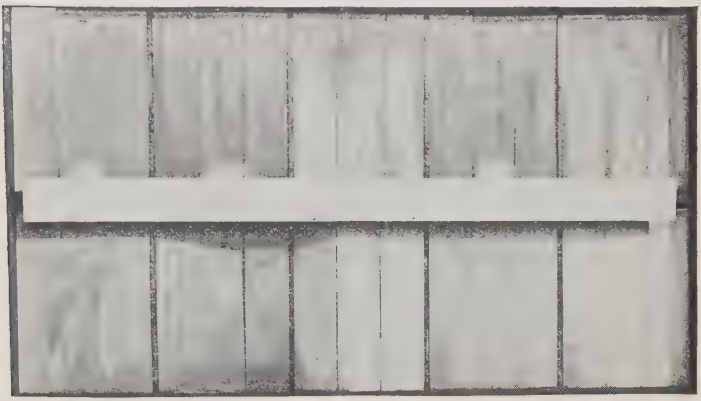


FIG. 10.

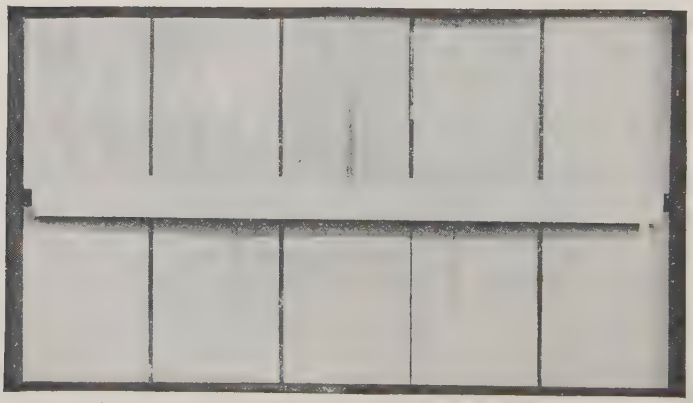


FIG. 11.

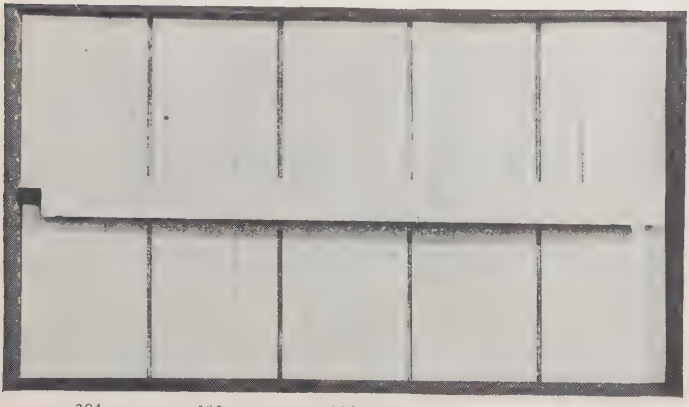


Fig. 12.

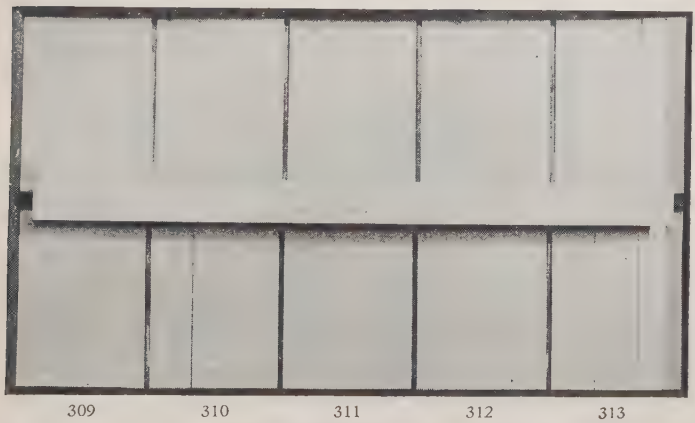


Fig. 13.

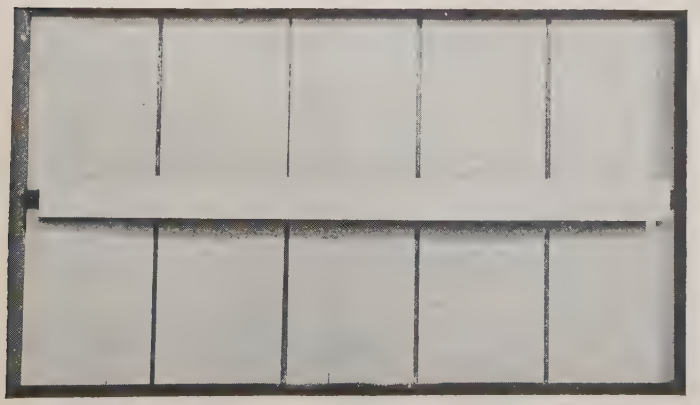


Fig. 14.

FIG. 15.

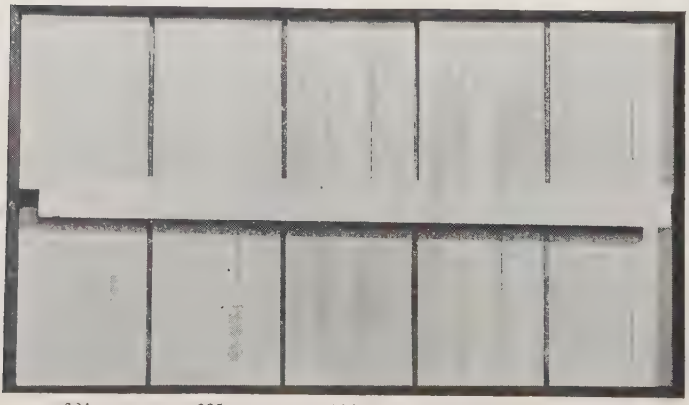


FIG. 16.

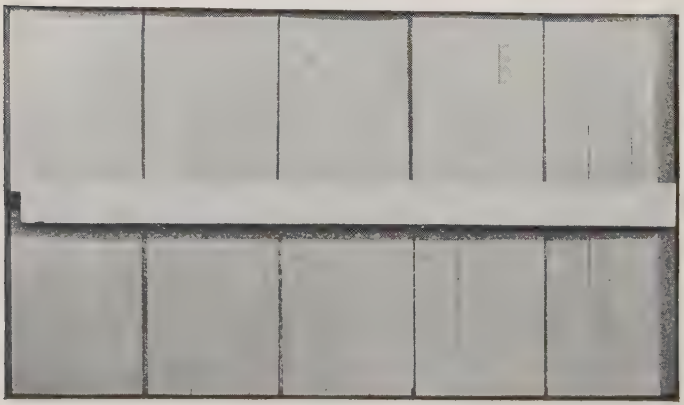


FIG. 17.

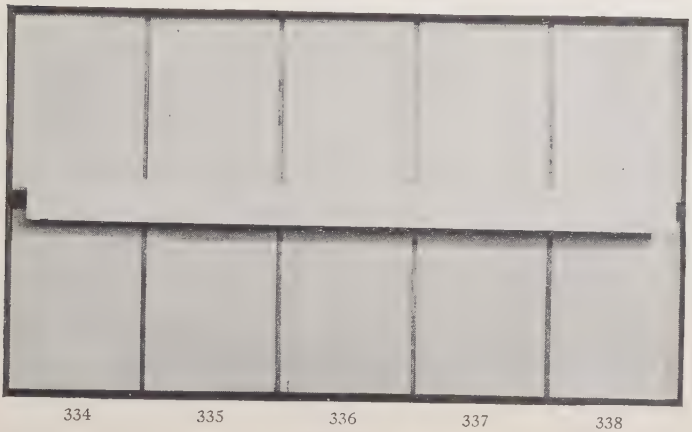


Fig. 18.

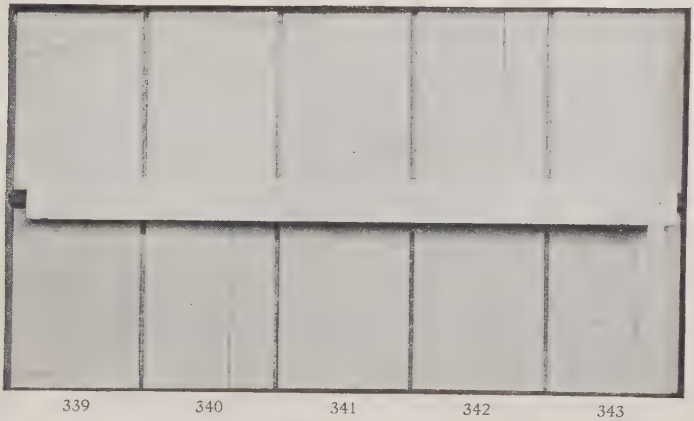
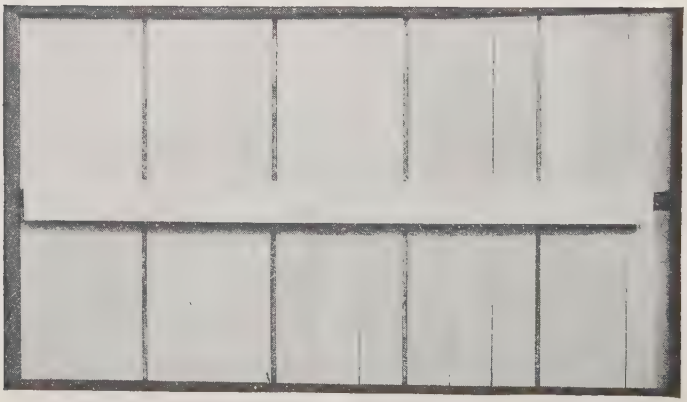


Fig. 19.

Fig. 20.

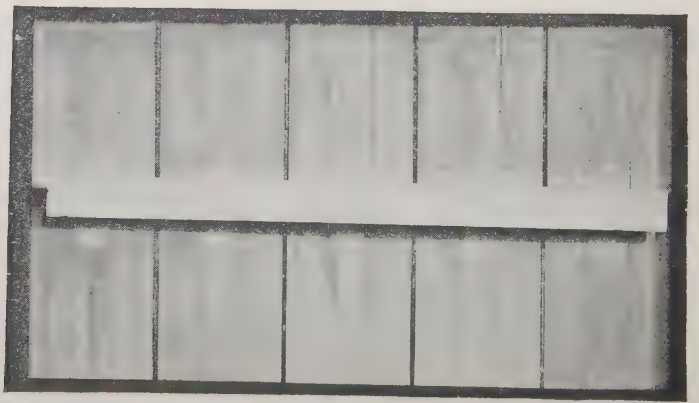
349 350 351 352 353

FIG. 21.



354 355 356 357 358

FIG. 22.

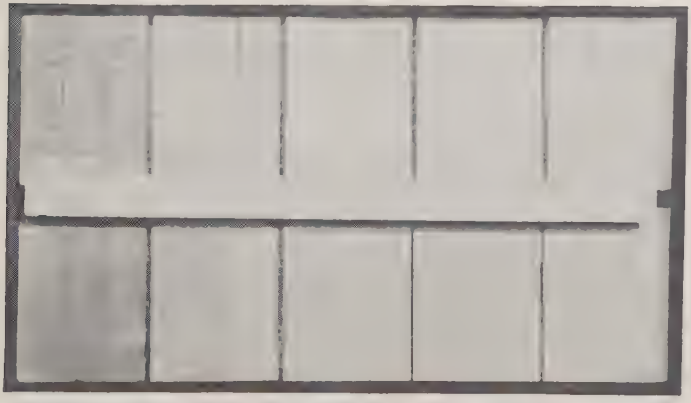


359 360 361 362 363

FIG. 23.

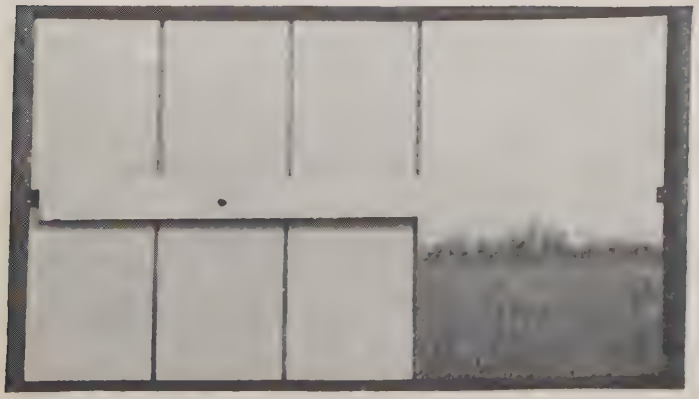
364 365 366 367 368

Fig. 24.



369 370 401 402 403

Fig. 25.



404 405 406

Fig. 26.

REPORT OF SUB-COMMITTEE XI ON PAINT THINNERS OTHER THAN TURPENTINE.

Sub-Committee XI on Paint Thinners other than Turpentine has no definite recommendation to make at this time. This report is, therefore, one of progress and an outline of the sub-committee's plan.

The work undertaken has for its ultimate object the formation of specifications for the class of materials with which the committee has to deal. In order that specifications may be useful and effective it is necessary that standard methods of test be adopted. The immediate object of the work already done and of that planned is the adoption of suitable methods of test by means of which these products may be investigated and standards finally established.

Among the qualities to be determined for this class of materials are the following:

1. Distillation range, comprising initial boiling and drying points and percentages at various temperature intervals;
2. Evaporation, including rate and residue;
3. Solvent power with various gums or oils;
4. Flash point;
5. Color;
6. Sulfur, or that portion of it which may be in such a chemical state as to discolor certain pigments.

On the tests to be used in determining the above qualities the following progress has been made:

Distillation.—A method of conducting the distillation test, which is an adaptation or combination of the one in common use in the coal-tar products industry and of that in use in the petroleum laboratories, has been drawn up and submitted to the members of the sub-committee for trial and criticism. The method has such slight modifications from those which have been in very general use for several years that there seems to be very little experimental investigation called for before reaching a decision on this matter.

Evaporation.—For the determination of rate of evaporation and of residue on evaporation, there seems to be in general use only such crude tests as placing a small quantity of the material on a piece of absorbent paper and noting the time required for evaporation and also the residual spot left on the paper. Members of the sub-committee have been experimenting with more suitable tests and it is hoped that before long a tentative method may be outlined for investigation.

Solvent Power.—This also is a quality for the determination of which no method is in any general use at the present time. It is an important quality particularly to the varnish maker. Members of the sub-committee are working on the subject and some results may be hoped for in the near future.

Flash Point.—There are so many kinds of apparatus in use in this country for the determination of flash point and there is such a lack of agreement between the users as to which form of apparatus is best suited to the materials with which this sub-committee deals, that it was deemed best to conduct a rather extensive series of tests before adopting even a tentative standard. This work on flash point was no sooner started than other organizations interested in the subject expressed a willingness to co-operate through their own committees on the same subject. The organizations referred to are the National Fire Protection Association, National Paint Oil and Varnish Association, Paint Manufacturers' Association, and Varnish Makers' Association. Each of them has at least one representative on this sub-committee.

The plan being followed in endeavoring to formulate a standard method for the determination of the flash point of paint thinners is one which has been used by several other committees of the society in choosing a standard method of test, namely, to send portions of a standard sample to a large number of laboratories to be tested by all of the various methods under consideration. The results obtained are tabulated and the method giving the most satisfactory results, all things considered, is chosen as the standard method.

In order to secure the cooperation of a large number of laboratories a letter was addressed to some two hundred of

ORIGINAL

FLASH TEST REPORT.

AMERICAN SOCIETY FOR TESTING MATERIALS.

SUB-COMMITTEE XI OF COMMITTEE D-1 ON PAINT THINNERS OTHER THAN TURPENTINE.

N. B.—Follow closely the Instructions on Method of Making Tests which are furnished by the Committee

TWO COPIES OF EACH REPORT ARE TO BE RETURNED TO THE SECRETARY.

Test made at Lab. of.....at.....Under direction of.....

Sample No.....Kind of Material.....Made by.....

Kind of Cup.....Identifying Marks (Mfgrs. brand or name).....

For Tagliabue, and Elliot or N. Y. State Tester give following additional information:—

Total capacity (in c. c.) of oil cup..... Weight (in g.) of oil cup.....

Inside diameter (in inches) at top of oil cup.....

Test No.	Date Made.	Name Operator.	Temp. Room.	Bar.	Hum.	Temp. Water Bath at Start.	Temp. Sample at Start	Temp. Sample First Test.	Time of applying first test.	Method Employed A or B.	Flash Point, Deg. Cent.	Time of Flash Point	Remarks.

Original and Duplicate copies of this report to be sent to Chas. A. Lunn, Secretary, 175 Front Street, New York City, N. Y.

Signed.....

them asking their assistance. Replies were received from 93 and of these 43 expressed a willingness to cooperate in the work.

In answer to questions asked in the sub-committee's letter it was ascertained that the laboratories willing to cooperate possessed the following flash cups:

Tagliabue open	24
Elliot or New York State	23
Abel-Pensky	9
Pensky-Martins	7
Cleveland	6
Abel	4
Scott	3
Saybolt	2
Special types	7

It was decided to accept the assistance of those laboratories having at least two kinds of cups so that comparisons could be made. There were 20 such laboratories, which in addition to the 25 available to members of the sub-committee made a total of 45 laboratories to conduct and report on flash-point tests, all using the same paint thinner furnished by the sub-committee.

A carefully drawn set of minute instructions for the operation of each of the types of cups was then forwarded with general instructions to each of the laboratories and to each member of this sub-committee. Blank forms were furnished in triplicate for use in reporting results of tests. Two copies of each form were to be returned to the committee and the third retained by the laboratory. A copy of the form used accompanies this report.

These tests are now in progress and results are expected at an early date.

The matters of color and sulfur content have not as yet been taken up by the sub-committee.

Respectfully submitted on behalf of the sub-committee,

CLOYD M. CHAPMAN,
Chairman.

REPORT OF SUB-COMMITTEE XII ON TURPENTINE.

The sub-committee submits the following report on its work on the examination of samples of turpentine preliminary to the preparation of specifications for turpentine.

Samples.

The samples were collected by the Bureau of Chemistry of the Department of Agriculture in collaboration on this work. They were taken personally by Inspector J. J. McManus, and the history of each sample is taken from his signed statement.

Turpentines Sent out by the American Society for Testing Materials.

Sample No. 1.—Five gallons taken from the first part of the distillate from a charge of 12 bbl. of Virgin Dip Gum (tapped spring of 1913). The first gallon rejected because of green color from dissolved copper. Total yield of distillate from charge, 132 gal. Capacity of still, 30 bbl. of 50 gal. each. All gum obtained from trees within radius of 15 miles of Summit, Emanuel County, Ga., shipped in 5-gal. boxed can sealed with wax, made by Summit Naval Stores Co., Summit, Ga. Collected by Inspector J. J. McManus, October 24, 1913.

Sample No. 2.—Five gallons from last of distillate from charge of 12 bbl. of Virgin Dip Gum (tapped spring of 1913). From the same run as sample No. 1.

Sample No. 3.—Five gallons taken from first part of distillate from a charge of 9½ bbl. of Old High Box Gum (3 years or over). The first gallon of distillate rejected because of green color due to dissolved copper. Total yield of distillate from charge, 95 gal. Capacity of still, 30 bbl. of 50 gal. each. All gum obtained from trees within a radius of 15 miles of Summit, Emanuel County, Ga. Shipped in 5-gal. boxed can sealed with wax, made by the Summit Naval Stores Co., Summit, Ga. Collected by Inspector J. J. McManus, October 24, 1913.

Sample No. 4.—Five gallons from last of distillate from charge as sample No. 3. Last 4 gal. rejected to avoid skimming. Same run as sample No. 3.

Sample No. 5.—Five gallons of wood turpentine taken from galvanized-metal stock tank. Product was made and refined on October 25, 1913, made by the destructive distillation of yellow pine wood. Shipped in 5-gal. jacketted can sealed with paper seal and wax; box sealed with lead seal, made by Chatham Manufacturing Co., Savannah, Ga. Collected by Inspector J. J. McManus, October 27, 1913.

Sample No. 6.—Five gallons regular grade wood turpentine taken from 10 bbl. in lot of 60 bbl. received in Savannah. Product is a steam distilled wood turpentine. Wood obtained from Southern Georgia Pine. Made by the Yaryan Naval Stores Co., Brunswick, Ga. Shipped in 5-gal. jacketted can sealed with paper seal and wax; box sealed with lead seal. Collected by Inspector J. J. McManus.

These samples were all delivered to the Leather and Paper Laboratory, Bureau of Chemistry, Washington, D. C., where they were sub-divided and distributed in sealed containers by the laboratory to the collaborators.

METHODS OF EXAMINATION.

It was requested that the samples be examined in accordance with the following methods:

DIRECTIONS FOR THE ANALYSIS OF TURPENTINE.

Appearance.—On receipt of samples, note and record whether the samples are free from dirt, suspended matter and water. If the samples contain water, filter through a dry filter paper into a clean dry bottle.

Color.—Into a 200-mm. colorimeter tube graduated into millimeters, place 50 cc. of the turpentine to be examined; on the tube place a No. 2 Lovibond yellow glass; over a second 200-mm. tube, place a No. 1 Lovibond yellow glass; add to the second tube enough of the sample of turpentine to match the color in the first tube, and record its reading in millimeters.

Specific Gravity.—Determine the specific gravity by any suitable accurate method and report as specific gravity at 15°.5/15°.5 C. State the method used.

Refractive Index.—Determine with a direct reading refractometer at 15°.5 C.

Distillation Test.—(1) Place 200 cc. of the sample into a 300-cc. flask, 8 cm. in diameter, with a side tube 8 cm. from the main bulb, and the neck extending 8 cm. above the side tube. The neck is 2 cm. in diameter and the side tube 5 mm. This flask should be fitted with a thermometer (reading from 145 to 200° C.) immersed in the vapor. The mercury bulb should be opposite the side tube of the flask and the reading 175° C. should be below the cork. The distillation should be so conducted that there shall pass over about 2 drops of the distillate per second.

(2) Place 100 cc. of the sample into an ordinary Engler flask.[1] Have thermometer totally immersed in the vapor as directed in the specifications in test No. 1.

(3) Place 100 cc. of the sample in an ordinary Engler flask (see test No. 2) and use an ordinary long-stem thermometer. Report emergent read-

[1] Stillman, "Engineering Chemistry," p. 503.

ing and approximate length of the exposed mercury column and its approximate temperature.

In all three methods of distillation note and report the initial boiling point. Note temperature at each 10 cc. of distillate and note volu e of distillate at 160, 165, 170 and 175° C. If possible, note and report barometric pressure at time of making distillation.

Evaporation Test.—Ten cubic centimeters of the sample are placed in a glass crystallizing dish, $2\frac{1}{2}$ in. in diameter and $1\frac{1}{8}$ in. high, and evaporated on an open steam bath with a full head of steam for 2 hours. Cool, weigh, and report weight of residue in grams.

Polymerization.—(1) Add slowly 5 cc. of the turpentine to 25 cc. of sulfuric acid, sp. gr. 1.84, contained in an ordinary, graduated, narrow-necked Babcock flask. Shake the flask with a rotary motion to insure gradual mixing. Cool if necessary in ice water, not permitting the temperature to rise above 60 to 65° C. Agitate thoroughly and maintain at about 65° C. with frequent agitations for 1 hour. Cool, fill the flask with H_2SO_4, bringing the unpolymerized oil into the graduated neck. Allow to stand 1 hour. Read off unpolymerized content; note and report its consistency and color, and determine its refractive index at 15°.5 C.

(2)[1] Repeat test No. 1 but use sulfuric acid that is 38N and let flasks stand 24 hours before reading the amount of unpolymerized residue, or else centrifuge 5 minutes.

Hydrochloric-Acid Test.—Shake 10 cc. of the turpentine with 10 cc. of concentrated hydrochloric acid, sp. gr., 1.19. Note whether after 3 minutes standing a decided red color develops. (Test for the presence of furfural or heavy or resinous oils.)

Flash Point.—(1) Support a 100-cc. nickel crucible, such as is used in determining the flash point of linseed oil, in a vessel of water at 15 to 20° C.; the water should cover about two-thirds of the crucible. Fill the crucible to within about 2 cm. of the top with turpentine, insert a thermometer, and heat the water bath slowly so that the temperature of the turpentine rises 1° C. per minute. Begin at 37° C. and test for the flash at each rise of 0°.5 C. Report temperature at which the turpentine flashes.

(2) Determine the flash point using the Tagliabue open cup. Begin testing at 30° C. and test at each degree Centigrade above that till the sample flashes. The temperature of the turpentine should not rise more rapidly than 1° C. per minute.

(3) Use a closed tester such as the Pensky-Martin tester, the Abel cup, etc., following the directions for the instrument.

LIST OF COLLABORATORS.

The following laboratories and analysts participated in the collaborative work:

1. Institute of Industrial Research, H. A. Gardner and L. G. Carmick, Washington, D. C.

[1] Donk's Method; *Bulletin No. 135* or *Circular No. 15*, Bureau of Chemistry.

2. Bureau of Chemistry, E. W. Boughton.

3. Bureau of Chemistry, C. F. Speh for F. P. Veitch.

4. Bureau of Standards, S. S. Voorhees and F. A. Wertz, Washington, D. C.

5. General Naval Stores Co., Charles A. Lunn, New York, N. Y.

6. Bureau of Standards, H. W. Bearce and E. D. Tillyer.

The results obtained by the several analysts have been summarized in Tables I to XII, inclusive.

Discussion.

Appearance.—The comments upon the appearance of samples as received probably require no discussion other than to state that all turpentine samples should be filtered through paper before they are analyzed, for the purpose of removing dirt and water which they may contain. It is possible that it would be well to chill the samples thoroughly before filtering, in this way removing as much of the dissolved water as practicable.

Color.—Only two of the analysts reported results on color, and as but two of the samples were darker than water white, they furnished but little opportunity to compare analysts' figures. Agreement on samples Nos. 2 and 4, however, by the two of the analysts reporting is not good.

Specific Gravity.—The results on specific gravity are very satisfactory, with possibly one exception, and seem to indicate that results accurate to within 0.002 can be obtained with either a hydrometer, plummet or Westphal balance.

Refractive Index.—The results require no comment and are, with possibly one or two exceptions, very good.

Distillation.—The results for methods Nos. 1 and 3, although in a few instances not varying as widely as might be expected from the individual temperature readings, do in general show much larger volumes as distilling below certain limits by method No. 3 than by methods Nos. 1 or 2. Results obtained by methods Nos. 1 and 2 are much more concordant, although we also see variations here, and these variations occur in those samples which gave close agreement for methods Nos. 1 and 3, namely, samples with a large volume distilling at or below 150° C.

TABLE I.—APPEARANCE OF SAMPLES AS RECEIVED.

Analyst No.	Sample No. 1.	2.	3.	4.	5.	6.
1	Analyzed as received.	Analyzed as received.	.....	.....	None filtered.	.....
2[a]	Clear.	Contains few little drops of water.	Contains little sediment.	Contains few drops of water.	Clear.	Clear.
3[a]	Clear; considerable water; no dirt.	Clear; some water; some dirt.	Clear; drops water; some dirt.	Clear; drops water; some dirt.	Clear; no water; no dirt.	Clear; no water; no dirt.
4[b]	Clear; slightly turbid on cooling below 15° C.	Clear.	Turbid, with clearing and decided sediment on standing; filtered sample slightly turbid on cooling below 15° C. Tests on filtered sample.	Turbid, with clearing and brown sediment on standing. Tests made on filtered sample.	Clear.	Clear.

[a] All filtered through paper before making analysis.

[b] All filtered before making analysis.

TABLE II.—COLOR OF SAMPLES.

VALUES IN MILLIMETERS.

Analyst No.	Sample No. 1.	2.	3.	4.	5.	6.
1	....	....	....	....	....	....
2	+200	44/50 ..47	+200	42/50 ..46	+200	+200
3	+200	36	+200	..	+200	+200
4	....	....	....	....	....	....
5	+200	116	+200	86	+200	+200
6	....	....	....	....	....	....

TABLE III.—SPECIFIC GRAVITY AT 15°.5/15°.5 C.

Analyst No.	Sample No. 1.	2.	3.	4.	5.	6.
1[a]	0.8650	0.8690	0.8655	0.8685	0.8590	0.8630
2[b]	0.8665 0.8662	0.8715 0.8711	0.8677 0.8671	0.8712 0.8718	0.8613 0.8615	0.8653 0.8649
	0.8663	0.8713	0.8674	0.8715	0.8614	0.8651
3	0.8670 0.8668	0.8705	0.8678	0.8743	0.8614	0.8651
	0.8669					
4	0.8653	0.8702	0.8670	0.8707	0.8605	0.8647
5	0.8665[c] 0.8644[d]	0.8725[c] 0.8699[d]	0.8680[c] 0.8649[d]	0.8710[c] 0.8746[d]	0.8615[c] 0.8609[d]	0.8670[c] 0.8649[d]
6	0.86607	0.87105	0.86733	0.87134	0.86126 0.86204	0.86523

[a] Hydrometer. [c] Westphal balance.
[b] Plummet. [d] Pyknometer.

TABLE IV.—REFRACTIVE INDEX AT 15°.5 C.

Analyst No.	Sample No. 1.	2.	3.	4.	5.	6.
1	1.4724	1.4761	1.4742	1.4745	1.4760	1.4704
2	1.4720	1.4764	1.4726	1.4753	1.4764	1.4707
3	1.4723	1.4759	1.4729	1.4759	1.4759	1.4716
4	1.4721	1.4751	1.4720	1.4748	1.4753	1.4695
5	.....	.....	.....	.....	.....	.....
6	1.4721	1.4761	1.4732	1.4754	1.4762	1.4716

TABLE V.—DISTILLATION: METHOD NO. 1.

Sample No.	Analyst No.	Barometric Pressure, mm.	Temperature (deg. Cent.) at which a given percentage distills.									Difference between Temperatures at 10 and 90 per cent.
			10	20	30	40	50	60	70	80	90	
1	1	.....	159.5	159.8	160.0	160.0	160.0	160.0	160.0	160.0	161.0	1.5
	2	754.0	158.2	158.4	158.8	159.2	159.4	159.8	160 4	161.2	164.2	6.0
	2	749.0	158.4	158.6	158.8	158.9	159.1	159.3	159.6	160.1	161.2	2.8
	3	760.0	158.9	159.0	159.1	159.3	159.5	159.6	159.8	160.7	163.3	4.4
	3	760.0	158.8	159.0	159.2	159.3	159.5	159.7	160.2	160.9	163.8	5.0
	4	760.7	158.0	158.4	158.5	158.6	158.8	159.0	159.2	159.7	160.7	2.7
	5	.....	159.4	159.5	159.7	159.8	159.9	160.1	160.5	161.0	162.0 163.6	....
2	1	.....	161.0	161.0	161.0	162.0	162.0	163.0	164.0	165.5	170.0	9.0
	2	748.0	161.3	161.8	162.2	162.6	162.9	163.8	164.6	166.5	171.6	10.3
	2	762.7	161.4	162.2	162.8	163.2	163.6	164.6	165.7	168.0	174.4	13.0
	3	760.0	161.6	162.0	162.5	162.8	163.4	164.1	165.8	168.6	.....	7.0
	3	760.0	161.7	162.2	162.5	162.8	163.5	164.2	165.3	167.0	172.4	10.7
	4	760.7	161.0	161.5	161.8	162.2	162.6	163.0	163.5	166.0	171.5	10.5
	5	.....	162.2	162.6	162.9	163.3	163.7	164.6	165.8	167.8	175.0 190.4	....
3	1	.....	160.0	160.0	160.0	160.0	160.0	160.0	160.0	160.0	162.0	2.0
	2	762.7	159.6	159.8	160.1	160.2	160.5	160.8	161.2	161.9	163.8	4.2
	2	762.7	159.6	159.8	160.2	160.4	160.6	160.8	161.2	161.9	163.7	4.1
	3	760.0	159.5	159.7	159.9	.....	160.5	160.7	161.5	162.4	.....	2.9
	3	760.0	159.3	159.6	159.8	160.2	160.4	160.7	161.2	161.8	164.6	5.3
	4	760.7	158.6	158.9	159.0	159.2	159.4	159.6	160.0	160.6	162.0	3.4
	5	.....	153.2	153.4	153.4	153.5	153.8	154.0	154.4	155.0	156.5 158.8	....
4	1	.....	161.5	162.0	162.0	162.0	162.5	163.0	163.0	167.0	171.0	9.5
	2	762.7	161.7	162.2	162.5	162.8	163.3	164.1	165.2	167.2	173.2	11.5
	2	762.7	161.7	162.1	162.3	162.8	163.3	164.0	164.9	167.0	172.2	10.5
	3	760.0	161.6	161.9	162.5	162.7	163.2	.....	164.7	167.5	.....	5.9
	3	760.0	161.3	161.7	162.2	162.6	163.1	163.8	164.9	168.8	172.2	9.9
	4	760.7	160.7	161.1	161.4	161.5	162.1	162.8	163.7	165.5	170.0	9.3
	5	.....	155.0	155.5	155.6	156.2	156.4	157.2	158.2	159.8	164.5 176.0	....
5	1	.....	165.0	167.0	167.5	168.5	170.0	172.0	173.5	.....	.....	8.5
	2	768.0	164.4	166.0	167.7	168.6	169.9	171.9	174.3	177.8	186.2	21.8
	2	768.0	164.3	166.7	167.4	168.3	169.9	171.7	174.0	177.1	184.4	20.1
	3	760.0	164.9	166.5	167.6	.....	169.3	.....	174.8	179.5	.....	14.6
	3	760.0	164.4	166.2	167.3	168.5	169.8	170.6	172.6	174.8	179.0	14.6
	4	760.7	164.0	164.6	166.0	166.8	168.2	168.8	171.9	175.0	.....	11.0
	5	.....	157.8	159.8	160.5	161.6	162.6	164.2	166.4	169.5	174.8 181.0	....
6	1	.....	160.0	161.0	161.5	162.0	162.0	163.0	164.0	166.5	170.5	10.5
	2	768.0	159.9	160.7	161.1	161.5	162.2	163.1	164.5	167.2	174.5	14.6
	2	768.0	159.8	160.5	161.0	161.5	162.0	163.0	164.4	166.6	173.9	14.1
	3	760.0	159.5	.....	160.7	161.0	161.7	162.3	163.4	.....	169.4	9.9
	3	760.0	159.6	160.1	160.7	161.3	161.8	162.8	164.4	166.5	.....	6.9
	4	760.7	159.0	159.5	160.0	160.1	160.7	161.6	163.0	165.3	171.0	12.0
	5	.....	160.0	160.2	160.6	161.4	162.0	162.8	163.6	166.0	172.2 183.0	....

TABLE VI.—DISTILLATION: METHOD NO. 2.

Sample No.	Analyst No.	Barometric Pressure, mm.	Temperature (deg. Cent.) at which a given percentage distills.								
			10	20	30	40	50	60	70	80	90
1	1	.....	159.5	160.0	160.0	160.0	160.0	160.0	161.0	161.0	162.5
	2	765.5	159.4	159.6	159.8	160.0	160.2	160.6	161.2	162.2	165.6
	2	765.5	159.0	159.4	159.6	160.0	160.2	160.4	161.0	162.0	164.8
	3	759.5	159.0	159.4	159.5	159.7	159.9	160.2	160.9	162.0	165.0
	3	759.5	158.9	159.3	159.5	159.7	159.9	160.3	160.8	163.2	.....
	4	756.0	157.9	158.4	158.6	158.7	158.9	159.2	159.5	160.0	161.2
2	1	.....	162.0	163.0	163.0	164.0	164.0	165.0	166.0	168.0	174.0
	2	765.5	162.0	162.4	162.8	163.2	163.4	164.4	165.4	167.2	173.6
	2	766.0	162.0	162.6	163.0	163.4	163.8	164.6	165.6	167.4	174.4
	3	759.5	161.9	163.0	163.1	163.7	164.5	165.9	167.2	169.0	.....
	3	772.5	162.8	163.4	163.9	164.3	165.0	166.1	168.1	170.0	.....
	4	756.0	161.0	161.5	161.9	162.4	162.8	163.7	164.6	166.4	173.0
3	1	.....	160.0	160.5	160.5	161.0	161.0	161.0	161.5	162.0	.....
	2	762.2	159.2	159.6	159.8	1.0.2	160.4	161.0	161.6	163.0	165.0
	2	762.2	159.2	159.6	160.0	160.4	160.0	161.0	161.6	162.6	164.8
	3	772.5	158.5	160.4	160.9	161.2	161.6	161.9	162.7	163.8	.....
	3	772.5	.....	160.5	160.8	161.0	161.3	161.9	162.4	163.7	.....
	4	756.0	158.7	159.0	159.2	159.4	159.6	159.8	160.3	160.8	162.1
4	1	.....	162.0	162.5	163.0	163.0	163.0	164.0	165.5	167.9	.....
	2	762.2	161.2	161.8	162.2	162.4	163.0	163.8	165.0	166.6	174.8
	2	762.2	160.6	161.2	161.4	162.2	162.6	163.2	164.4	166.6	171.8
	3	771.9	162.3	162.8	163.4	163.8	164.4	165.0	165.9	169.2	.....
	3	779.5	163.0	163.4	163.7	164.3	164.7	165.9	167.3	169.6	.....
	4	756.0	160.5	161.3	161.5	161.9	162.3	162.8	163.7	165.2	169.8
5	1	.....	165.0	167.0	168.0	169.0	170.0	172.0	174.0	177.0	.....
	2	762.2	164.8	165.8	167.0	168.0	169.6	171.2	172.8	175.0	182.0
	2	762.2	164.6	166.2	167.2	168.2	169.4	171.0	172.8	176.2	182.6
	3	772.5	165.7	167.6	168.5	169.8	171.1	172.8	174.2	177.8	184.0
	3	772.5	165.4	167.0	168.7	170.0	171.5	173.0	175.0	180.0	.....
	4	756.0	163.3	165.0	166.0	167.0	168.5	170.0	172.0	174.0	.....
6	1	.....	161.0	161.0	161.5	162.0	163.0	164.0	165.0	168.0	173.0
	2	762.2	159.2	159.8	160.4	161.2	161.8	162.8	164.0	166.2	172.4
	2	762.2	159.4	159.8	160.4	161.2	161.8	162.6	164.0	166.2	172.6
	3	772.5	160.8	161.5	162.4	162.7	163.2	164.9	166.8	169.8	.....
	3	771.9	160.6	161.2	161.7	162.5	163.5	164.7	166.9	168.9	.....
	4	756.0	159.0	159.3	159.5	160.3	161.0	161.7	162.9	165.2	172.0

TABLE VII.—DISTILLATION: METHOD NO. 3.

Sample No.	Analyst No.	Barometric Pressure, mm.	Temperature (deg. Cent.) at which a given percentage distills.								
			10	20	30	40	50	60	70	80	90
1	1	.....	157.0	157.5	158.0	158.0	158.0	158.0	159.0	159.5	161.0
	2	771.2	157.0	157.0	157.0	157.5	158.0	158.0	158.5	160.0	163.5
	2	771.2	157.0	157.0	157.0	157.5	158.0	158.0	158.5	160.0	163.0
	3	779.5	158.0	158.5	158.5	158.5	159.0	159.0	159.5	160.5	161.0
	3	779.5	157.5	158.0	158.5	158.5	158.5	159.0	159.5	160.5	162.0
	4	750.2	154.8	155.1	155.4	155.7	155.9	156.1	156.3	157.0	157.8
2	1	.....	159.0	160.0	160.5	161.0	162.0	162.5	163.0	165.5	170.0
	2	771.2	159.5	160.0	160.5	160.5	161.5	162.0	163.5	165.0	170.5
	2	771.2	159.5	160.0	160.5	161.0	161.5	162.5	163.5	165.0	170.5
	3	760.0	159.0	159.5	160.0	160.5	161.3	161.5	162.8	165.0	171.0
	3	760.0	159.0	159.7	160.3	160.5	161.2	162.0	163.2	165.1	170.5
	4	750.2	157.8	158.4	158.9	159.3	159.4	160.3	161.3	163.2	168.3
3	1	.....	157.0	158.0	158.0	158.5	158.5	159.0	159.0	160.0	161.0
	2	771.2	157.0	157.5	158.0	158.5	158.5	159.0	159.5	160.5	163.0
	2	770.9	157.0	157.5	157.5	158.0	158.5	158.5	159.5	160.5	162.5
	3	760.0	157.2	157.3	157.5	157.8	158.2	158.8	159.3	161.2	.....
	3	760.0	157.0	157.2	157.4	158.0	158.2	158.4	159.1	159.7	162.0
	4	750.2	155.3	156.0	156.2	156.3	156.4	156.6	156.9	157.1	158.3
4	1	.....	160.0	160.0	160.5	161.0	162.0	162.5	163.0	165.5	.....
	2	770.2	159.0	159.5	160.0	160.5	161.0	161.5	162.5	165.0	170.0
	2	770.2	158.5	159.5	160.0	160.0	161.0	161.5	162.0	165.0	170.5
	3	760.0	158.5	159.3	159.7	160.3	160.6	161.5	162.5	164.3	169.8
	3	760.0	158.4	159.4	159.6	160.2	160.6	161.5	162.5	164.3	171.1
	4	750.2	157.3	157.6	158.1	158.5	159.1	159.7	160.4	162.3	166.9
5	1	.....	163.0	163.0	165.0	167.0	168.0	169.0	172.0	175.0	180.0
	2	770.2	162.0	163.0	164.5	165.5	167.0	169.0	171.0	173.5	179.5
	2	770.2	162.5	164.0	165.0	166.0	167.0	169.0	170.5	174.0	180.5
	3	760.0	161.2	163.2	164.2	165.4	.....	167.5	170.2	174.1	.....
	3	760.0	160.3	162.3	164.3	165.7	167.2	169.2	172.0	.....	.....
	4	750.2	160.3	161.6	162.9	163.8	165.0	166.8	169.3	172.3	.....
6	1	.....	158.0	158.0	159.0	159.5	160.5	161.5	162.5	165.0	172.0
	2	770.2	157.0	157.5	158.5	158.5	159.5	160.0	161.0	163.5	169.5
	2	770.2	157.0	158.0	158.5	159.0	159.5	160.5	161.5	164.5	169.5
	3	760.0	157.2	158.0	158.5	159.2	159.5	160.7	162.2	164.2	171.0
	4	750.2	155.3	155.9	156.8	157.3	158.0	158.6	159.7	162.3	168.1

TABLE VIII.—COMPARISON OF METHODS OF DISTILLATION.

Analyst No.	Method of Distillation, No.	Barometric Pressure, mm.	Initial Distilling Point, deg. Cent.	Percentage Distilled below			
				160° C.	165° C.	170° C.	175° C.
Sample No. 1.							
1	1	.....	152.0	25.0	98.0	99.0	.....
	2	.....	157.0	20.0	96.0	99.0	.....
	3	.....	155.0	88.0	97.0	98.0	99.0
2	1	754.0–749.0	156.5	64.0– 80.0	91.0– 96.0	94.0– 97.0	95.0
	2	765.5	157.0–156.0	23.0– 34.0[a]	89.0– 90.0[a]	94.0– 94.0[a]	95.0– 95.0[a]
	3	771.2	155.0	85.0– 85.0[b]	94.0– 94.0[b]	95.0– 95.0[b]	96.0– 96.0[b]
3	1	760.0	156.5	73.0– 89.0	96.0– 96.0	97.0– 98.0	.....
	2	759.5–759.5	157.5–157.5	54.0– 56.0	90.0– 84.0	94.0– 89.0	97.0– 97.0
	3	760.0	154.2–154.0	84.5– 82.5	96.0– 96.7	.....	.....
4	1	760.7	152.0	83.0	97.0	98.0	99.0
	2	756.0	153.0	80.0	97.0	98.0	99.0
	3	750.2	146.0	96.0	97.0	98.0	99.0
5	1	.....	157.0	60.0	96.8	98.0	.....
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....
Sample No. 2.							
1	1	.....	154.0	2.0	78.0	82.0	95.0
	2	.....	160.0	.....	60.0	85.0	92.0
	3	.....	158.0	20.0	76.0	90.0	92.0
2	1	748.0–762.7	159.5	1.1	73.0–65.0	87.0–85.0	92.0–91.0
	2	765.5–766.0	160.0	1.0– 1.0[a]	65.0–64.0[a]	86.0–86.0[a]	92.0–91.0[a]
	3	771.2	158.0–157.0	30.0–30.0[b]	83.0–82.0[b]	90.0–90.0[b]	93.0–93.0[b]
3	1	760	160.5	.....	71.0–68.0	88.0–88.0	92.0–93 0
	2	759.5–772.5	161.0–161.0	.....	56.0–49.0	81.0–79.0	89.0–88.0
	3	763.0	156.2–156.7	29.4–29.0	79.6–79.5	87.9–89.2	.....
4	1	760.7	157.5	4.0	76.0	89.0	94.0
	2	756.0	158.0	2.0	74.0	89.0	94.0
	3	750.2	154.0	58.0	86.0	92.0	95.0
5	1	.....	160.0	.....	65.0	85.0	90.0
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....
Sample No. 3.							
1	1	.....	157.0	10.0	96.0	98.0	.....
	2	.....	158.0	10.0	94.0	99.0	.....
	3	.....	155.0	80.0	97.0	99.0	.....
2	1	762.7–762.7	157.5	25.0–26.0	93.0–93.0	96.0–96.0	97.0–97.0
	2	762.2	158.0	23.0–25.0[a]	89.0–90.0[a]	94.0–94.0[a]	95.0–95.0[a]
	3	771.2–770.9	155.0	80.0–81.0[b]	94.0–95.0[b]	95.0–96.0[b]	96.0–97.0[b]
3	1	760.0	157.5	35.0–39.0	93.0–95.0	96.0–99.0	.....
	2	772.5	158.0–158.0	9.0– 8.0	85.0–85.0	93.0–93.0	97.0–98.0
	3	763.0	155.0–155.0	70.0–75.0	91.4–92.2	93.5–93.7	.....
4	1	760.7	153.0	70.0	95.0	97.0	98.0
	2	756.0	154.0	65.0	95.0	97.0	98.0
	3	750.2	151.0	95.0	97.0	98.0	99.0
5	1	.....	151.0	96.5	97.5	.....	.....
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....

[a] Percentages are for 0°.2 lower than the temperature stated.
[b] Percentages are for 0°.4 higher than the temperature stated.

TABLE VIII—COMPARISON OF METHODS OF DISTILLATION—(*Continued*).

Analyst No.	Method of Distillation, No.	Barometric Pressure, mm.	Initial Distilling Point, deg. Cent.	Percentage Distilled below			
				160° C.	165° C.	170° C.	175° C.
Sample No. 4.							
1	1	.....	158.0	0.0	78.0	88.0	94.0
	2	.....	160.0	.....	65.0	85.0	94.0
	3	.....	157.0	10.0	79.0	91.0	95.0
2	1	762.7–762.7	160.0	0.0– 1.0	69.0–72 0	87.0–88.0	91.0–92.0
	2	762.2	156.0–155.0	2.0– 4.0[a]	69.0–76.0[a]	86 0–88.0[a]	90.0–92.0[a]
	3	770.2–770.2	157.0	40.0–43.0[b]	84.0–83.0[b]	90.0–90.0[b]	92.0–92.0[b]
3	1	760.0	160.5	.....	72.0–72.0	89.0	94.0–92.0
	2	771.9–779.5	160.5–161.0	.....	60.0–52.0	84.0–82.0	91.0–89.0
	3	771.0	154.0–155.0	27.0–25.8	74.6–75.6	82.6–84.4	.....
4	1	760.7	156.0	2.0	79.0	90.0	94.0
	2	756.0	156.5	5.0	79.0	91.0	94.0
	3	750.2	152.0	65.0	87.0	93.0	96.0
5	1	.....	151.0	81.0	90.5	93.5	94.0
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....
Sample No. 5.							
1	1	.....	159.0	0.0	10.0	50.0	77.0
	2	.....	162.0	.....	10.0	50.0	74.0
	3	.....	159.0	3.0	30.0	63.0	80.0
2	1	768.0–768.	160.0	0.0	14.0–13.0	51.0–51.0	73.0–73.0
	2	762.2	160.0	.....	10.0–12.0[a]	55.0–56.0[a]	77.0–78.0[a]
	3	770.2–770.2	157.0	8.0– 8.0[b]	38.0–38.0[b]	69.0–70.0[b]	84.0–85.0[b]
3	1	760.0	160.0	.....	10.0–13.0	53.0–56.0	75.0–77.0
	2	772.5–777.5	163.5–162.5	.....	8.0– 6.0	44.0–41.0	73.0–71.0
	3	771.0	156.0–156.5	3.6– 5.8	31.8–35.6	63.6–66.5	79.8
4	1	760.7	152.0	2.0	22.0	61.0	81.0
	2	756.0	153.0	2.0	20.0	60.0	82.0
	3	750.2	153.0	8.0	50.0	72.0	88.0
5	1	.....	152.0	24.0	63.7	80.7	90.2
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....
Sample No. 6.							
1	1	.....	156.0	10.0	72.0	88.0	95.0
	2	.....	159.0	.....	70.0	86.0	90.0
	3	.....	156.0	43.0	80.0	88.0	94.0
2	1	768.0–768.0	158.0	11 0–14.0	73.0–73.0	86.0–88.0	91.0–91.0
	2	762.2	155.0–156.0	19.0–18.0[a]	74.0–76.0[a]	87.0–88.0[a]	94 0–94.0[a]
	3	770.2–770.2	154.0–155.0	63.0–60.0[b]	85.0–85.0[b]	92.0–92.0[b]	94.0–94.0[b]
3	1	760.0	157.5	17.0–19.0	78.0–75.0	89.0–87.0	93.0–92.0
	2	772.5–771.9	159.5–158.5	5.0– 5.0	62.0–67.0	83.0–83.0	88.0–90.0
	3	771.0	155.5–155.5	62.9–61.2	83.6	89–7–89.7	.....
4	1	760.7	153.0	30.0	80.0	89.0	94.0
	2	756.0	153.5	34.0	80.0	88.0	93.0
	3	750.2	145.0	72.0	87.0	92.0	94.0
5	1	.....	154.0	10.0	75.0	88.0	93 5
	2	.....	.....	.....	.....	.....	.....
	3	.....	.....	.....	.....	.....	.....

[a] Percentages are for 0°.2 lower than the temperature stated.
[b] Percentages are for 0°.4 higher than the temperature stated.

Table IX.—Evaporation Tests.

Analyst No	Dishes.	Time of Evaporation, hours.	Sample No. 1. Residue, g. per 10 cc.	1. Barometric Pressure during Evaporation, mm.	2. Residue, g. per 10 cc.	2. Barometric Pressure during Evaporation, mm.	3. Residue, g. per 10 cc.	3. Barometric Pressure during Evaporation, mm.	4. Residue, g. per 10 cc.	4. Barometric Pressure during Evaporation, mm.	5. Residue, g. per 10 cc.	5. Barometric Pressure during Evaporation, mm.	6. Residue, g. per 10 cc.	6. Barometric Pressure during Evaporation, mm.
1			0.0222		0.1550		0.0244		0.1130		0.2316		0.1330	
2	Dishes directly on rings of steam bath.	2	0.1036	748–753	0.1868	748–753	0.0518	748–753	0.1538	763	0.2130	763	0.2156	763
			0.1302	768	0.1392	768	0.0554	768	0.1582		0.1892	753	0.1800	753
		4	0.0808	748–753	0.1712	748–753	0.0464	748–753	0.1352		0.1848	763	0.1728	763
			0.0776	768	0.1206	768	0.0522	768	0.1312		0.1722	753	0.1520	753
	Dishes raised slightly above rings of bath by thin sheet of glass.	2	0.0966	748–753	0.1372	748–753	0.0476	748–753	0.1540		0.2408	763	0.2132	763
			0.1374	768	0.1332	768	0.0570	768	0.1272		0.2320	753	0.1948	753
		4	0.0776	748–753	0.1258	748–753	0.0406	748–753	0.1334		0.2060	763	0.1708	763
			0.1000	768	0.1200	768	0.0458	768	0.1138		0.1926	753	0.1618	753
3	Prescribed dishes.	2	0.0640	772	0.2251	772	0.0983	772	0.3826		0.3287	772	0.1747	772
			0.0737	772	0.2351	772	0.0949	772	0.3914		0.3325	772	0.1750	772
			0.0531	765	0.2152	765	0.0799	765	0.1856		0.2098	765	0.2442	765
	Dishes, $2\frac{5}{8}$ by $1\frac{5}{8}$ in.	2	0.0624	772	0.2231	772	0.0891	772	0.3400		0.3233	772	0.1645	772
			0.0740	772	0.2516	772	0.0978	772	0.3169		0.3110	772	0.1381	772
			0.0363		0.1450		0.0584		0.1253		0.1763		0.0989	
		4	0.0499		0.2211		0.0731		0.2930		0.2708		0.1257	
			0.0585		0.2011		0.0848		0.2804		0.2610		0.1131	
		6	0.0484		0.2106		0.0701		0.2740		0.2478		0.1167	
			0.0535		0.1901		0.0798		0.2492		0.2420		0.0991	
4			0.0240		0.1213		0.0250		0.0720		0.1805		0.0470	
5	Constant.	2	0.2815		0.5888		0.1036		0.2848		0.5035		0.2699	
			0.0988		0.2845		0.0387		0.1820		0.3443		0.1439	

TABLE X.—POLYMERIZATION OR SULFONATION TEST.

WITH CONCENTRATED SULFURIC ACID.

Analyst No.	Sample No. 1.		2.		3.		4.		5.		6.	
	Unpolymerized Residue, per cent.	Refractive Index at 15° .5 C.	Unpolymerized Residue, per cent.	Refractive Index at 15° .5 C.	Unpolymerized Residue, per cent.	Refractive Index at 15° .5 C.	Unpolymerized Residue, per cent.	Refractive Index at 15° .5 C.	Unpolymerized Residue, per cent	Refractive Index at 15° .5 C.	Unpolymerized Residue, per cent.	Refractive Index at 15° 5 C.
1	10	.....	8.8	.....	10	.....	8.8	.....	11.2	.....	13.0	.....
2[a]	12	1.5110	9.4	1.5135	11.4	1.5100	10.6	1.5115	11.2	1.5080	11.4	1.5035
3	11.8	1.5080	9.4	1.5110	11.8	1.5080	10.4	1.5080	12.2	1.5050	13	1.5010
4	6.4	1.5120	5.6	1.5123	7.2	1.5093	6.0	1.5125	7.2	1.5095	8.2	1.5045
5	9.6	.....	10.4	.....	9.6	.....	8.8	.....	9.6	.....	10.4	.....

[a] At 15°.6 C.

WITH 38 N SULFURIC ACID.

1	1.2	.....	0.8	.....	1.2	.....	1.6	.....	1.0	.....	1.4	.....
2	0.8	.....	0.8	.....	0.8	.....	0.8	.....	0.8	.....	0.8	.....
3	0.4	1.5120	0.4	1.5160	0.4	1.5140	0.4	1.5140	0.5	1.5090	1.4	1.5010
4	1.6	1.5110	0.8	1.5115	0.8	1.5105	0.8	1.5115	0.8	1.5115	1.4	1.5020
5	1.2	.....	0.08	.....	0.04	.....	0.08	.....	0.08	.....	0.08	.....

NOTE.—In all cases the residue from polymerization were viscous and colored.

TABLE XI.—HYDROCHLORIC-ACID TEST.

Analyst No.	Sample No. 1.	2.	3.	4.	5.	6.
1	No color.	Reddish.	Very light red.	Decided red.	Red, lighter than No. 4.	Red, about like No. 5.
2	Pale yellow.	Light orange.	Very pale yellow.	Deep orange.	Reddish maroon.	Orange.
3[b]	Slightly turbid.	More turbid than No. 1.	Slightly turbid.	More turbid than No. 3.	Turbid, heavy and cloudy.	Turbid, heavy and cloudy.
4[c]	Cloudy, pale yellow.	Bright red.	Pale brown.	Dark brown red.	Dark red.	Dark red.
4	Very pale straw.	Pale yellowish brown.	Light straw.	Light yellowish brown.	Light brown yellow.	Light brown yellow.
5	Light yellow.	Dark orange.	Very pale yellow.	Very pale yellow.	Decided red.	Red.

[b] Immediately at junction.
[c] After shaking.

Table XII.—Flash Tests.

Analyst No.	Method.	Sample No. 1. Deg. Cent.	1. Barometric Pressure, mm.	2. Deg. Cent.	2. Barometric Pressure, mm.	3. Deg. Cent.	3. Barometric Pressure, mm.	4. Deg. Cent.	4. Barometric Pressure, mm.	5. Deg. Cent.	5. Barometric Pressure, mm.	6. Deg. Cent.	6. Barometric Pressure, mm.
1	Open Nickel Crucible	36.0	.....	38.0	.....	36.5	.....	36.5	.....	41.5	.....	35.5	.....
2	Open Nickel Crucible	48.0	756.0	49.0	756.0	46.0	768.0	48.0	768.0	56.0	788.0	47.0	766.0
	Tagliabue Open Cup.	44.0	768.7	44.0	768.7	41.0	764.8	41.0	764.8	41.0	764.8	42.0	764.8
		40.0	751.7	41.0	751.7	42.0	751.7	41.0	751.7	44.0	753.8	42.0	753.8
		41.0	756.0	42.0	756.0	.....	.....	.....	.....	.....	.....	.....	.....
	Abel-Pensky Cup.	36.0	768.7	37.0	768.7	35.0	768.7	37.0	764.8	38.5	764.8	35.0	764.8
		35.0	751.7	37.5	751.7	35.0	751.7	36.5	751.7	38.5	751.8	35.0	753.1
	Nickel Crucible filled	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Nickel Crucible, 1 cm. from edge	.....	.....	.....	.....	44.0	768 0	.....	.....	.....	.....	.....	.....
	Nickel Crucible, ½ cm. from edge	.....	.....	.....	.....	37.0	766.0	.....	.....	.....	.....	.....	.....
3	Nickel Crucible, filled	42.0	.....	46.5	.....	45.0	.....	46.0	.....	48.0	.....	49.0	.....
	Nickel Crucible, 2 cm. from top	43.5–43.0	.....	46.0–46.5	.....	47.0–46.0	.....	46.0–46.0	.....	49.0–48.5	.....	50.0–49.5	.....
	Nickel Cru ible, 1 cm. from top.	39.2	.....	40.0	.....	40 0	.....	39.0	.....	44.0	.....	41.0	.....
		38.8–39.0	.....	41.0–40.5	.....	40.0–40.0	.....	40.0–39.5	.....	45.0–34.4	.....	41.0–41.0	.....
	Tagliabue Cup.	39.0	.....	42.0	.....	40.0	.....	40.0	.....	45.0	.....	42.0	.....
		39.0–39.0	.....	41.5	.....	39.5	.....	40.5	.....	43.0	.....	41.5	.....
		39.0	.....	41.0	.....	39.0	.....	41.0	.....	42.0	.....	41.0	.....
	Abel-Pensky Cup.	34.0	.....	37.0	.....	34.5	.....	36.0	.....	37.5	.....	36.5–36.5	.....
		33.0–33.5	.....	37.0–37.0	.....	33.0–34.0	.....	37.0–36.5	.....	37.5–37.5	.....	38.0	.....
4	Nickel Crucible	39.0	.....	40.5	.....	37.5	.....	.....	.....	44.0	.....	43.0	.....
5	Abel Cup.	31.5	.....	35.0	.....	31.0	.....	34.5	.....	38.0	.....	33.0	.....

One large cause of variation might be pointed out, namely, the effect of uncorrected barometric pressure. In those cases of duplicate distillations by the same analyst under the same barometric pressure, better checks are obtained than under different pressures.

It is to be regretted that more results were not reported, so as to be able to arrive at more definite conclusions regarding the checks obtained in the hands of the different analysts.

While there is not much room for preference, on the whole, it appears that the results of the different analysts agree better by method No. 1 than by either of methods Nos. 2 and 3. This agreement is not as close, however, as it was expected to be.

It is very doubtful if any useful information is to be obtained by noting the temperature at each 10 cc. of the distillation. The sub-committee believes that sufficient information is furnished by noting the initial distilling temperature and percentage distilled below 160, 165, 170 and 175° C.

Evaporation Test.—Results obtained are far from satisfactory, although any individual analyst's figures place the turpentines in their probable relative order. There are, however, very poor checks among the different analysts, and a comparison of one analyst with another would not necessarily place the turpentines in their proper order.

The sub-committee feels that the results obtained do not warrant the inclusion of specifications for evaporation at this time.

Polymerization or Sulfonation Test.—The residues on polymerization with ordinary concentrated sulfuric acid are entirely too large to make the procedure adaptable for detecting small percentages of mineral oil. This conclusion agrees with that previously reached by several of the collaborators.

The results with a strictly 38 N (100.92 per cent) sulfuric acid are, in general, quite satisfactory, though it seems as if the results of analyst No. 1 are uniformly higher than they should be. This method, if properly conducted, is believed to be very satisfactory for detecting small quantities of mineral oil in turpentines.

Hydrochloric-Acid Test.—It is very doubtful if this test shows anything of value beyond indicating whether the turpentine

contains appreciable amounts of furfural, and possibly of heavy oils.

Flash Tests.—The results on flash tests are too incomplete for the committee to recommend any form of apparatus for making this test. It is recommended that the results of the investigations of Sub-Committee XI on Paint Thinners other than Turpentine be awaited before further work on this subject. Sub-Committee XI is making a careful study of the methods for determining flash point and there seems to be no need of this sub-committee duplicating this work. It may be pointed out, perhaps, that the open nickel crucible is entirely unsatisfactory, and that while very good results were obtained with the Abel-Pensky cup, the number of collaborators was too few to justify the sub-committee in recommending this procedure without further experiments.

After careful consideration of the results before the sub-committee, it has reached the decision that it is in a position at this time to prepare specifications which shall include only general appearance, color, specific gravity, refractive index, initial distilling point, distillation below 170° C., and residue on polymerization.

The matters of residue on evaporation, flash point and behavior during fractional distillation must await additional results of a concordant nature to enable the sub-committee to make recommendations of value.

The sub-committee transmits herewith in Tables I to XII, inclusive, the individual reports of the several collaborating laboratories, together with supplementary reports on the density and thermal expansion of turpentine by H. W. Bearce, on refractive indices by E. D. Tillyer, and on color by I. G. Priest of the Bureau of Standards (Appendices I, II and III). Finally, it proposes specifications for turpentine, and recommends in reference thereto (1) that further work be done by the sub-committee to devise a simple and reliable way for performing the evaporation test; (2) that further work on flash point await the results of Sub-Committee XI on Paint Thinners other than Turpentine, and then that several of the most promising methods settled upon by that sub-committee be investigated with respect to their adaptability to turpentine; and (3) that

further work be done on distillation with a view to securing more concordant and better agreeing results by different operators; that in this work the thermometers used by the collaborators shall first be checked together by the Bureau of Standards and not used in other work before this experimental work is performed; and that more carefully defined conditions as to method of heating the flasks, control of pressure, speed of distillation and noting initial distilling temperature be prescribed.

There are attached hereto Specifications for Turpentine, which are tentative and not offered for adoption by the Society at this time.

Respectfully submitted on behalf of the sub-committee,

F. P. VEITCH,
Chairman.

APPENDIX I.

SUPPLEMENTARY REPORT ON THE DENSITY AND THERMAL EXPANSION OF TURPENTINES.

By H. W. Bearce.

About three years ago (June and July, 1911), the author made several determinations of the density and thermal expansion of turpentine. The results of this investigation, together with the results of similar work on linseed oil, have been published.[1]

At the 1913 meeting of the American Society for Testing Materials it was decided that samples of turpentine of known origin and purity should be collected by the Society and work carried out similar to that previously done on linseed oil. Samples were accordingly collected, bottled, and sealed, under the direction of the Society and the sealed samples were later delivered to the chemists to whom the analyses had been entrusted. The samples were put up in individual sets, each set consisting of a 1-qt. and a 1-pt. bottle of each sample. One set of these samples was delivered to Mr. S. S. Voorhees, of the Bureau of Standards, and of this set the 1-pt. bottles, still under seal, were turned over to the author. The results here given were obtained from these samples.

Method Employed.

The method employed in making the density determinations was that known as the method of hydrostatic weighing. In this method a sinker or plummet, of known mass and volume, is weighed in the sample whose density is to be determined, and from the known constants of the sinker and its loss of

[1] *Technologic Paper No. 9*, Bureau of Standards; *Proceedings*, Am. Soc. Test. Mats., Vol. XI, p. 211 (1911).

weight when weighed in the liquid, the density at the temperature of the observations is calculated.[1]

RESULTS.

Six samples of turpentine were examined and the density of each sample was determined at 0, 10, 20, 25, 30, 40 and 50° C. Then from the observed density values an expression was deduced to represent the rate of change of density over the temperature range covered by the observations. It was found that the rate of expansion could be accurately expressed by means of an equation of the form.

$$D_t = D_x + \alpha(t-x) + \beta(t-x)^2 + \gamma(t-x)^3 + \text{etc.} \qquad (1)$$

For the samples examined it was found that all terms involving t above the second power could be neglected. Also it was found convenient to choose for x the mean value of the temperature, 25° C. Equation (1) therefore becomes

$$D_t = D_{25} + \alpha(t-25) + \beta(t-25)^2 \qquad (2)$$

By means of equation (2) the density at any temperature t can be calculated from the density at 25° C., if the values of α and β are known. From the density values for each sample the most probable values of D_{25}, α and β are found by the application of the method of least squares.

The results of the density determinations on the six samples of turpentine are shown in Table I.

By substituting in equation (2) the average values of α and β from the above table, the average rate of expansion of the samples examined will be expressed thus,

$$D_t = D_{25} - 0.000817(t-25) - 0.000\,000\,10(t-25)^2 \qquad (3)$$

A few words of explanation in regard to equation (3) may not be out of place. The fact that α is negative means, of course, that the density decreases as the temperature increases. The fact that β is negative means that the rate of change of density is greater at the high than at the low temperatures.

[1] For details of this method and description of apparatus, see *Technologic Paper No. 9*, Bureau of Standards, or *Proceedings*, Am. Soc. Test. Mats., Vol. XI, p. 211 (1911); or *Bulletin No. 197* (reprint), Bureau of Standards, Vol. 9, No. 3.

TABLE I.—DENSITY[1] AND THERMAL EXPANSION OF SAMPLES OF TURPENTINE.

Sample No.	Densities.									Specific Gravity at	
	D_0	D_{10}	D_{20}	D_{25}	D_{30}	D_{40}	D_{50}	$\alpha \times 10^6$	$\beta \times 10^8$	$\frac{15°.5}{15°.5}$ C.	$\frac{25°}{25°}$ C.
5	0.87299	0.86490	0.85679	0.85273	0.84867	0.84052	0.83235	−813	−10	0.86126	0.85523
5	0.87376	0.86568	0.85758	0.85352	0.84946	0.84132	0.83318	−812	− 8	0.86204	0.85602
6	0.87713	0.86891	0.86071	0.85661	0.85251	0.84430	0.83609	−821	− 1	0.86523	0.85912
1	0.87787	0.86973	0.86157	0.85747	0.85337	0.84513	0.83687	−820	−17	0.86607	0.85998
3	0.87915	0.87100	0.86284	0.85874	0.85464	0.84643	0.83819	−819	−11	0.86733	0.86126
2	0.88280	0.87469	0.86656	0.86248	0.85840	0.85021	0.84200	−816	−13	0.87105	0.86501
4	0.88316	0.87500	0.86683	0.86274	0.85865	0.85044	0.84224	−819	− 7	0.87134	0.86527
Avg.	.....	.....	.....	.....	.....	.....	.....	−817	−10		

[1] Wherever the term "density" appears in this report it means the density in grams per milliliter; all densities here given are, therefore, numerically the same as specific gravities in terms of water at 4° C. as unity.

It is sometimes convenient to combine α and β into a single term which gives the change of density per degree at any desired temperature. This may be done by differentiating equation (2). It then becomes

$$\frac{dD_t}{d_t} = \alpha + 2\beta(t-25) \qquad (4)$$

This rate of change of density with respect to temperature may be called α'. The average values of α' at various temperatures, for the samples of turpentine examined are as follows:

TEMPERATURE, DEG. CENT.	α'
0	−0.000812
5	−0.000813
10	−0.000814
15	−0.000815
20	−0.000816
25	−0.000817
30	−0.000818
35	−0.000819
40	−0.000820
45	−0.000821
50	−0.000822

The results here given are in satisfactory agreement with those previously published.[1] The closeness of the agreement is in part accidental, as will be seen from a comparison of the results on the individual samples in the two series. The fact, however, that the average rates of expansion in the two series practically identical, indicates that the average results may be accepted without danger of serious error.

It will be seen from Table I that for sample No. 5 two sets of results are given. The reason for this is that in the course of the density determinations it was noticed that in the case of certain samples successive determinations at the same temperature showed an increase in density. For example, if the density of a sample was determined in the morning and again in the afternoon it would be found that a noticeable increase had occurred. This progressive change was especially marked in sample No. 5. In the course of a few days a very considerable increase occurred. Whether this change in density is caused by a slow oxidation of the turpentine by its contact with air, or whether it is due to the escape of the lighter and more volatile constituents of the material, can not be told with certainty; it may be in part due to each, and also to the effect of light. But it seems probable that it can be attributed chiefly to the passing off of the more volatile constituents. Whatever the cause of the change it is certain that if turpentine is to retain a definite density it cannot be left open or exposed to the air.

Several observations were made to determine the magnitude of the change of density of various samples.

All samples, except sample No. 5, when left in the densimeter tube exposed to the air were found to increase in density at the rate of from 6 to 12 units of the fifth decimal place for each 24 hours. The surface exposed was the cross-section of a tube 2.5 cm. in diameter and the capacity of the tube was about 120 cc. The rate of change of density was noticeably greater at the high than at the low temperatures.

For sample No. 5 a considerably higher rate of change was found. In one case two successive determinations showed a difference of 22 in the fifth decimal place, and most of this

[1] *Technologic Paper No. 9*, Bureau of Standards.

change occurred within a period of 3 hours. Two other determinations on this sample showed an increase of 6 in the fourth place in 2 days. On continued exposure to the air the rate of change became less; so that after a few days the rate was found to be about the same as for the other samples. It would appear, therefore, that this sample, when bottled, contained a large amount of highly volatile material which rapidly escaped when the sample was exposed to the air.

The density changes here given are intended only to show that measurable changes occur when turpentine is exposed to the air, even for a few hours. The actual magnitude of the changes here reported should not be given great weight.

A few experiments were also made to determine the effect of dissolved air on the density of turpentine. In order to remove the air from the sample the containing tube was connected with a vacuum pump and the air pressure over the sample reduced until the liquid boiled freely. The air was thus removed from the sample and immediately thereafter the density of the sample was determined. After the determination of the density of the air-free sample, dry air was bubbled through it for a period of about 10 minutes, after which the density was again determined. This process was repeated as many times as desired. In a few cases there was evidence that the density was somewhat less when the sample was saturated with air, but in most cases any slight difference which may have occurred from this cause was entirely masked by the more pronounced progressive increase already referred to and ascribed to the oxidation and evaporation of the liquid.

In conclusion the author would acknowledge his indebtedness to Mr. E. L. Peffer for valuable assistance rendered in the report here presented.

APPENDIX II.

SUPPLEMENTARY REPORT ON REFRACTIVE INDICES OF TURPENTINES.

By E. D. Tillyer.

The samples of turpentine were taken from the six standard turpentines collected by the American Society for Testing Materials. Before being received for the refractive-index determinations, a part of each bottle had been withdrawn for the density determinations, leaving the bottles practically half full for some time.

The indices were determined on the Pulfrich refractometer with careful temperature control, the constants of the refractometer being checked before each determination by means of a standard sample of glass, the index of which for the sodium line is known to the fifth decimal place. The corrections applied amounted only in one case to 1 unit in the fourth decimal place.

Table I.—Refractive Indices of Turpentines.

Sample No.	Refractive Index at			$\alpha \times 10^4$	$\beta \times 10^4$
	15° C.	25° C.	35° C.		
1	1.4721	1.4678	1.4631	−4.50	−0.018
2	1.4761	1.4717	1.4670	−4.54	−0.012
3	1.4732	1.4689	1.4641	−4.56	−0.020
4	1.4754	1.4710	1.4663	−4.57	−0.015
5	1.4762	1.4716	1.4668	−4.67	−0.012
6	1.4716	1.4671	1.4625	−4.60	−0.000

The indices at any temperature between 15 and 35° C. may be found from

$$N_t = N_{25} + \alpha\,(t - 25) + \beta(t - 25)^2$$

The effect of exposure on the turpentines was determined in the following way:

Air was bubbled for 10 hours through about 30 cc. of each sample of turpentine, and the indices then determined as previously explained for 25° C. These are given in Table II under 25° C., exposed. The differences between the exposed and unexposed are also given.

Table II also contains the logarithm of the Lorentz Specific Refraction, which is computed by means of the previous indices and the densities as furnished by Mr. Bearce.

It will be noticed in Table II, that under the Lorentz Specific Refraction sample No. 5 is distinctly different from the other samples. It is difficult to assign a definite explanation to this, in view of the limited knowledge of the chemical combinations of the different samples.

In conclusion, the author would acknowledge his indebtedness to Mr. H. I. Shultz for valuable assistance rendered in the report here presented.

TABLE II.—REFRACTIVE INDICES OF TURPENTINES.

Sample No.	Refractive Index at 25° C., Exposed.	Difference between Exposed and Unexposed Samples.	Lorentz Specific Refraction at 25° C.
1	1.4680	+0.0002	9.5106
2	1.4723	+0.0006	9.5112
3	1.4692	+0.0003	9.5108
4	1.4714	+0.0004	9.5105
5	1.4720	+0.0004	9.5161
6	1.4677	+0.0006	9.5105

APPENDIX III.

SUPPLEMENTARY REPORT ON COLOR OF TURPENTINES.

By I. G. Priest.

April 14, 1914.

Mr. F. P. Veitch,
Chairman, Sub-Committee XII of Committee D-1.

Dear Sir:

In connection with the tests on the turpentine submitted by your sub-committee, the absorption spectra of three of the

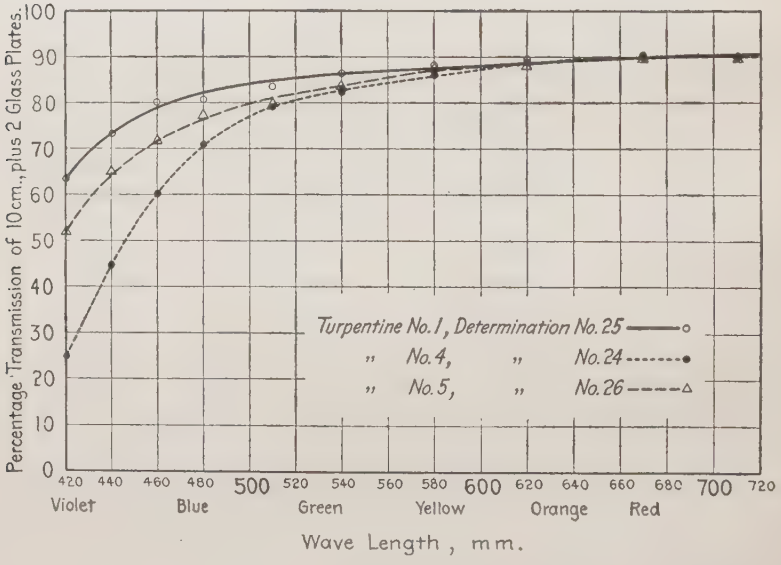


Fig. 1.

samples have been determined. The resulting curves are submitted in Fig. 1. The absolute values are not reliable but the relative differences in the blue are quite significant.

We understand that means of maintaining the color stand-

ard from year to year is lacking, and beg to suggest that the absorption coefficient of some definite wave length or spectral region in the blue might be specified. This would be a definite physical index of the color, and errors from year to year would not be cumulative, as in the present method. The curves submitted herewith will serve to indicate to your sub-committee the magnitude of the variation of percentage transmission in known samples. If this suggestion meets with favor we can then take up the matter of a specification on this basis more in detail.

Respectfully,

S. W. Stratton,
Director, Bureau of Standards.
By I. G. Priest.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED SPECIFICATIONS FOR TURPENTINE.

Classes. 1. These specifications apply both to the turpentine that is distilled from pine oleoresins, and commonly known as gum turpentine or spirits turpentine, and to the turpentine commonly known as wood turpentine that is obtained from resinous wood, whether by extraction with volatile solvents, or by steam, or by destructive distillation.

The specifications do not attempt to differentiate between the two, provided they fully meet all requirements of the specifications. The purchaser, when ordering under these specifications, should specify whether gum, spirits or wood turpentine is desired.

General Appearance. 2. The turpentine must be clear and free from suspended matter and water.

Color. 3. The color shall be "Standard."

Specific Gravity. 4. The specific gravity shall not be less than 0.860, nor more than 0.875, at 15°.5 C.

Refractive Index. 5. The refractive index shall be not less than 1.468, nor more than 1.478, at 15°.5 C.

Initial Boiling Point. 6. The initial boiling point shall be not less than 150° C., nor more than 160° C.

Distillation. 7. Ninety per cent of the turpentine shall distill below 170° C.

Polymerization. 8. The polymerization residue shall not exceed 1 per cent and its refractive index at 15°.5 C. shall not be less than 1.500.

METHODS OF ANALYSIS.

Specific Gravity.—Determine specific gravity at any convenient temperature with an accurate, standardized plummet, or by any equally accurate method, using the factor 0.00082 for each degree that the temperature of determination differs from 15°.5 C.

Refractive Index.—Determine refractive index at any convenient temperature with an accurate instrument, and calculate the results to 15°.5 C., using the factor 0.00045 for each degree that the temperature of determination differs from 15°.5 C.

Distillation.—Use an ordinary Engler flask and condenser,[1] and heat the flask by placing it in a glycerine or oil bath of the general type described in Bulletin No. 135, Bureau of Chemistry. Fit the flask with a thermometer reading from 145 to 200° C. in such a way that the mercury bulb shall be opposite the side tube of the flask and the 175° mark below the cork. Place 100 cc. of the turpentine to be examined in the flask, connect with the condenser, insert stopper bearing thermometer, and heat until distillation of the turpentine begins. Conduct the distillation so that the distillate passes over at the rate of 2 drops per second. Note the initial distilling temperature and the percentage distilling below 170° C.

Polymerization.—Place 20 cc. of exactly 38N (100.92 per cent) sulfuric acid in a graduated, narrow-neck Babcock flask, stoppered, and place in ice water and cool. Add slowly 5 cc. of the turpentine to be tested. Gradually mix the contents, cooling from time to time, and not allowing the temperature to rise above about 60° C. When the mixture no longer warms up on shaking, agitate thoroughly and place the bottle in a water bath and heat from 60 to 65° C. for about 10 minutes, keeping the contents of the flask thoroughly mixed by vigorous shaking five or six times during the period. Do not stopper the flask after the turpentine has been added, as it may explode. Cool to room temperature, fill the flask with concentrated sulfuric acid until the unpolymerized oil rises into the graduated neck. Centrifuge at about 1200 r. p. m. from 4 to 5 minutes, or allow to stand for 12 hours. Read unpolymerized residue, notice its consistency and color, and determine its refractive index.

[1] Stillman, "Engineering Chemistry," p. 503.

REPORT OF SUB-COMMITTEE XIII ON SHELLAC.

The two reports submitted herewith as Appendices I and II are both on subjects which have been thoroughly investigated in the past. Both of these methods are arbitrary methods used for convenience and speed, but not necessarily giving accurate percentages of the rosin and the insoluble matter present. The test for rosin has been really standard for some time and has been the subject for investigation by a committee of the American Chemical Society.[1] In reporting a proposed standard method, the sub-committee has omitted all the non-essentials and given only those points essential to such a method. The wording is largely that of the report of the committee of the American Chemical Society. The members of the sub-committee, all of whom have been using the method, can now attest to its reliability, and they feel that it should eventually be incorporated in the standard methods of the American Society for Testing Materials.

The insoluble test for shellac has been previously reported by the committee before it became a sub-committee of the Society and it has been published in part.[2] However, one or two paragraphs in the form of amendments are new, and the past year's work, using the proposed standard method, makes it desirable that this proposed method be also incorporated in the standard methods of this Society.

One or two other methods of shellac analysis—notably the ones for the determination of moisture and arsenic—are now under investigation and will be reported upon at some later date.

It is the desire of this sub-committee that its personnel be enlarged, that standard samples be filed with the Bureau of Standards, and that cooperative work be done on these samples following the tentative standard methods here submitted.

Respectfully submitted on behalf of the sub-committee,

C. T. Bragg,
Chairman.

[1] *Journal*, Am. Chem. Soc., Vol. 29, p. 1221 (1907).
[2] *Journal of Industrial and Engineering Chemistry*, Vol. 5, p. 435 (1913).

APPENDIX I.

DETERMINATION OF ROSIN IN SHELLAC.

The result of our work convinces us that the Wijs process used as proposed by Doctor Langmuir, one of our number, possesses the desirable features of regularity and reliability in a greater degree than any other process which has come to our notice. With this process, it is possible to carry out a test of a sample of shellac in a few hours, and as shellac is a rather expensive material and one very liable to sudden changes in price, it is almost essential that the standard method of testing shall be a rapid one.

The method which we would recommend as a standard method for the determination of rosin in shellac is substantially the one described by Doctor Langmuir.[1]

Proposed Standard Method for the Determination of Rosin in Shellac.

The solutions required are one of iodine monochloride containing 13 g. of iodine per liter, in glacial acetic acid that has a melting point of 14.7 to 15° C. and is free from reducing impurities; and another of sodium thiosulfate, made by dissolving 24.83 g. of the pure salt in a liter of water. In addition to these solutions there is required a quantity of acetic acid of the same strength as that used for making the solution of iodine monochloride. Pure chloroform and starch are also necessary. The preparation of the iodine-monochloride solution presents no great difficulty, but it must be done with care and accuracy in order to obtain satisfactory results. There must be in the solution no sensible excess either of iodine or more particularly of chlorine, over that required to form the monochloride. This condition is most satisfactorily attained by dissolving in the whole of the acetic acid to be used the requisite quantity of iodine, using a gentle heat to assist the solution, if it is found necessary. Set aside a small portion of this solution, while pure, and pass dry chlorine into the remainder until the halogen content of the whole solution is doubled. Ordinarily it will be found that by passing the chlorine into the main part of the solution until the characteristic color of free iodine has just been discharged, there will be a slight excess of chlorine, which is corrected by the addition of the requisite amount of the unchlorinated portion

[1] *Journal*, Soc. Chem. Ind., Vol. 24, p. 12 (1905); *Journal*, Am. Chem. Soc., Vol. 29, p. 1221 (1907).

until all free chlorine has been destroyed. A slight excess of iodine does little or no harm, but excess of chlorine must be avoided.

Introduce 0.2 g. of ground shellac into a 250-cc. dry bottle of clear glass with a ground glass stopper, add 20 cc. of glacial acetic acid (melting point 14.7 to 15° C.) and warm the mixture gently until solution is complete (except for the wax). A pure shellac is rather difficultly soluble; solution is quicker according to the proportion of rosin present. Ten cubic centimeters of chloroform are added and the solution is cooled to 21 to 24° C. The temperature should be held well within these limits during the test. Twenty cubic centimeters of Wijs solution are added from a pipette, having a rather small delivery aperture. The bottle is closed and placed in a dark place, and the time noted. It is convenient to keep the bottles during the test partly immersed in water which should be kept as nearly as possible between 22 and 23° C.

Pure shellac will scarcely alter the color of the Wijs solution. If in small amount, rosin will produce a slowly appearing red-brown color. In large amount, rosin causes an immediate coloration, increasing in intensity as time passes. After 1 hour, 10 cc. of 10-per-cent potassium-iodide water solution are added. The solution is immediately titrated with the sodium-thiosulfate solution; 25 or 30 cc. may be run in immediately, unless the shellac is very impure, and the remainder gradually, with vigorous shaking. Just before the end, a little starch solution is added. The end point is sharp, as the reaction products of shellac remain dissolved in the chloroform; any color returning after ½ minute or so is disregarded.

A blank determination should be run with 20 cc. of Wijs solution, 20 cc. of acetic acid, 10 cc. of chloroform, and 10 cc. of 10-per-cent potassium-iodide solution. The blank is necessary on account of the well-known effect of temperature changes on the volume, and possible loss of strength of the Wijs solution.

In the case of grossly adulterated samples, or in the testing of pure rosin, it is necessary to use, instead of 0.2 g. of material, a smaller amount, say 0.15 g. or even 0.1 g., in order that the excess of iodine monochloride may not be too greatly reduced, since the excess of halogen is one of the factors in determining the amount of absorption. It is safe to say that in case less than 25 cc. of the thiosulfate solution are required, another test should be made, using a smaller amount of the shellac to be tested.

In weighing shellac, some difficulty is at times experienced on account of its electrical properties. In very dry weather it may be found that the necessary handling to prepare it for weighing has electrified it, and that it may be necessary to leave it on the balance pan at rest for a few minutes before taking the final weight.

No pure shellacs show a higher iodine absorption than 18. As shellac is relatively a high-priced material and as the variation between its highest and lowest figure is not great, the subcommittee believes that 18 should be taken as the standard figure for shellac, determined by the method above described.

As it is an accepted principle that a standard method should be so devised that its inaccuracies shall work in the direction of favoring the seller rather than of condemning too severely the article sold, the sub-committee approves the value taken by Doctor Langmuir for the iodine number of rosin, namely, 228. The results of using in this method the value 18 as the iodine number of shellac and 228 as the number of rosin, may be that a slightly lower percentage of rosin, under some circumstances, will be found than that which is actually present.

The percentage of rosin is determined as follows:

$$\begin{aligned} &\text{Iodine number of shellac} = 18 \\ &\text{“ “ “ rosin} = 228 \\ &\text{“ “ “ mixture} = X \\ &\text{Percentage of rosin} = 100\,\frac{(X-18)}{(228-18)} \end{aligned}$$

APPENDIX II.

INSOLUBLE TEST FOR SHELLAC.

Shellac contains, in addition to the resin and wax, impurities such as sand, orpiment, charcoal, fibers, etc., which may amount to several per cent. Inasmuch as these materials are insoluble in dilute alkalies and in alcohol and are of no value to users of shellac, the determination of their amount is a matter of some importance. This has been recognized by the United States government in specifications for "orange-gum shellac," with the requirement that the insoluble residue after treatment with hot 95-per-cent alcohol shall not exceed 1.75 to 3 per cent, depending on the grade of shellac.

Grain-lac, which is prepared from stick-lac by crushing, washing and drying, may contain insect cells, sand, fragments of wood, etc., amounting to 3 per cent and upwards of matter insoluble in alcohol. Grain-lac brought into the United States is sold with a guarantee on alcohol-insoluble matter as determined by analysis, and it is therefore necessary to publish a method which may be depended upon to yield concordant results in the hands of various chemists. Considerable difficulty has been experienced with the usual forms of extraction apparatus on account of the wax present in shellac amounting to about 5 per cent. Shellac wax is soluble in boiling hot alcohol, but separates when cold and clogs the paper. A form of apparatus permitting continuous extraction with very hot alcohol is required.

Sub-Committee XIII, at a meeting at the Chemists' Club, New York, February, 1914, agreed upon the following method for the estimation of the proportion of alcohol-insoluble matter in stick-lac, grain or seed-lac, and shellac in its various forms. This agreement was reached after several months' work by each member of this sub-committee upon a standard sample of grain-lac. Several grades of methyl alcohol, as well as ethyl alcohol, and various types of apparatus were used, with the result that the apparatus shown in Fig. 1, and methyl alcohol

containing not more than 0.5 per cent of water and impurities, were adopted as the apparatus and solvent most likely to give uniform results in the hands of various operators.

The method has been approved by the United States Shellac Association.

Proposed Standard Insoluble Test for Shellac.

The separation of the soluble from the insoluble portion of the lac is made by extracting approximately 5 g. of the lac in a paper cartridge, which is held in a tube provided with a siphon as in the Knoefler extraction apparatus, and is heated by the vapors of the alcohol which pass around the tube and are then condensed by a return condenser to fall as liquid upon the shellac to be extracted. The siphon tube should be slightly larger than the cartridge, which should be supported so that it does not rest directly on the bottom.

The most convenient apparatus for carrying out the process is illustrated in Fig. 1. It consists of a wide-necked flask in which is suspended a metal return condenser. From the lower part of this condenser is hung a siphon tube of the Knoefler type. A Schleicher & Schuell extraction cartridge, No. 603, 26 mm. in diameter by 60 mm. high, is used in a siphon tube of such a size that the top of the cartridge is just above the upper curve of the siphon, the paper thimble being cut down if necessary. It is supported on three indentations in the glass so that there is a little space underneath and around the cartridge to allow of a free flow of liquid. To insure the complete extraction of all matters soluble in alcohol in the cartridge itself, it should be thoroughly extracted with 99.5-per-cent methyl alcohol before use. It is then placed in a glass-stoppered weighing bottle and dried to constant weight in an air bath at 100° C. A sample of approximately 5 g. of the pulverized lac is placed in the cartridge, which is then transferred to the extraction apparatus. The cartridge is filled with cold alcohol of the character described to a point just below the upper curve in the siphon. The cold alcohol is allowed to act upon the lac for 1 hour before the extraction commences.

During the extraction the alcohol is kept boiling briskly. The rate of extraction may be controlled by the use of an electric stove of the Simplex type, $4\frac{1}{2}$ in. in diameter, and using the full current of 2.2 amperes at 110 volts. The volume of methyl alcohol in the flask should be 125 cc. This is in addition to the alcohol required to fill the siphon. The flask should be protected from drafts. Under these conditions the tube will siphon over about 33 times in 1 hour. The condenser should be able to return all the alcohol volatilized during the vigorous boiling of the contents of the flask, the object being to effect the maximum extraction during the specified time.

The color is removed by the end of the first hour in practically every case and in order to eliminate any variations due to difference of opinion as to the exact time when the color has disappeared we recommend that the total extraction period be limited to exactly 2 hours, time being taken from the moment when the first siphon tube of alcohol has passed over. The cartridge

after extraction is placed in the weighing bottle, dried to constant weight at 100° C. and the whole weighed.

The weight of the residue insoluble in alcohol thus obtained, divided by the weight of the sample, and this quotient multiplied by 100, is the percentage of alcohol-insoluble matter in the lac.

In some quarters a similar test is known as the "refraction" of the lac.

It will be noted that there are three depressions in the lower part of the glass extraction thimble to hold the cartridge above the bottom. This is very necessary for the reason that during the early part of the extraction a

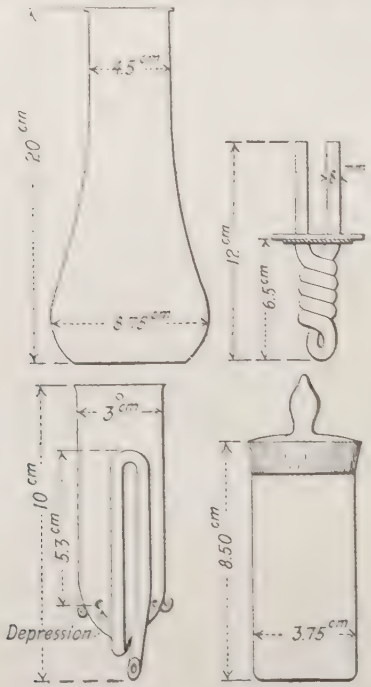


FIG. 1.—Apparatus for the Alcohol Insoluble Test.

very free flow must be maintained to prevent the blocking of the siphon with the wax, which, though readily soluble in hot alcohol, is with difficulty soluble in cold alcohol. The object in filling the cartridge with cold alcohol, before starting the extraction proper is to allow the resin and some of the wax to dissolve at a low temperature. If the higher temperature of the boiling alcohol were immediately applied it would fuse the resin into a lump and render the extraction difficult. The first few drops of distilled alcohol which fall into the cartridge will cause the extract to siphon over, thus eliminating the bulk of the resin at the start.

DISCUSSION ON THE REPORT OF COMMITTEE D-1.

Mr. Walker.

MR. P. H. WALKER (*Chairman of Committee D-1*). At a meeting of Committee D-1 held at Atlantic City on July 2, at which 32 of the 67 members of the committee were present, it was decided to recommend certain amendments to the report of the committee,[1] and that this report as thus amended be published in the Proceedings.

[A motion by Mr. Walker to that effect was carried.]

I move that the proposed Standard Definitions of Terms used in Paint Specifications, embodied in the report of the committee, which definitions have previously been published in the Proceedings of the Society as prescribed by the regulations, be referred to letter ballot.

[This motion was carried, but in pursuance of objections on the part of Mr. C. D. Rinald, it was reconsidered.]

Mr. Rinald.

MR. C. D. RINALD. I would suggest the following changes in the Proposed Standard Definitions of Terms used in Paint Specifications as given in the report of Committee D-1 on Preservative Coatings for Structural Materials:

Standard.—Possessing established quality or qualities;

Pure.—Not mixed with a foreign substance;

Adulteration.—The partial substitution of one substance for another to the detriment of the finished product;

Adulterant.—A substance used for adulteration;

Voids.—The spaces between the particles, either pigment or vehicle, occupied by air or gases;

Pigment.—Solid paint particles;

Volatile Thinner.—I have no fault to find with this definition, but believe its syntax favors misinterpretation. The words "except water" should be moved to the end of the sentence, or, better still, the entire sentence should be reconstructed.

[1] These amendments are listed in the Summary of the Proceedings, pp. 25–26.—ED.

Mr. Rinald.

Non-Volatile Vehicle.—The liquid portion of a paint excepting its volatile thinner and water;

Tint.—A color produced by mixing two or more pigments or paints, white predominating;

Shade.—A color produced by mixing two or more pigments or paints, black predominating;

Drying.—The gradual solidification of a liquid film;

Drier.—That which accelerates the drying of paint when added thereto;

Dry.—In the case of pigment, this means free from water; while in the case of paint films it means that the process of drying, as defined above, has reached such a stage that the painted surface may be exposed to use.

[On motion, the standard definitions of terms proposed by Committee D-1 were referred back to the committee.]

Mr. Carpenter.

MR. A. W. CARPENTER.—I wish to discuss the report of Sub-Committee II on Inspection of Havre de Grace Bridge. I am very much disappointed in this report with regard to the information relative to the composition of the paints that were used for the coatings. On the first page of this report a resolution of Committee D-1 appears which states that the committee holds that, as it entered into a contract with the paint manufacturers who furnished the paints for the Havre de Grace Bridge that the paints would not be identified with the manufacturers' names, therefore it is not authorized to furnish any information regarding these paints beyond that contained in the published reports of Committee D-1. But the published reports of Committee D-1 contain no information with regard to the nature of these paints except a very complete chemical analysis of each, expressed in chemical symbols, and a few fragmentary references to the composition of some of them, expressed in general terms. Now I think that after all the work that has been done, including the preparation, the painting and the various inspections, with the attention of the engineering and other technical bodies centered on these tests, a great deal more information should be and could be consistently given out with regard to the composition of the paints. In 1906, the Chairman's letter to the manufacturers explaining the nature of the test, stated that

the results obtained by this investigation of the American Society for Testing Materials "are intended to be of scientific value to the engineer, and to aid manufacturers in producing paint which will meet certain conditions, not to the advantage of any particular brand of paint." Now, engineers cannot very well interpret many of the terms of the chemical analyses and it seems to me that the committee, now that this test has practically come to a close, should amplify its report, giving a general description of the paints of each of the coatings, so far as it can without disclosing any confidential information it may have had from the manufacturers. I think it can do that so as to give a very good idea of the composition of the paints. In 1908 it referred to certain of the paints and coatings as "an asphaltum thinned with a petroleum volatile;" "a red lead undercoat and a carbon final coat." Of course that is not very much information, and more should be given if possible, but even that much would be very helpful in the interpretation of the results of the test. Mr. Carpenter.

I therefore wish to offer a motion that the committee amplify its report to give such information regarding the paints and coatings and also a brief résumé of the methods and conditions of the rest.

Mr. Walker.—In reference to this motion, I may say that that was entirely the desire of the committee, and to that end at least one sub-committee was appointed to prepare the information that Mr. Carpenter desires. I am not sure whether more than one sub-committee was appointed, but I do know that one was appointed, and that it worked very laboriously over the problem. It came to the conclusion that it could not —with that part of the information available which was not confidential, or even with the small amount of confidential information it had—prepare a statement as to the composition and nature of these paints that was anything other than the table of analyses. The table of analyses admittedly does not give the information we hoped to get when we started this test, but certain of the manufacturers declined to give us information in regard to what particular materials were used in their paints. Certain others, I believe, did give us some con fidential information. We could not, of course, use that and Mr. Walker.

Mr. Walker. we cannot deduce from the analysis or from any data that we have, the information that Mr. Carpenter wants and that we all want. It is very desirable that we should have it, but we just could not get it. The motion therefore requests the committee to do something which appears at the present time to be absolutely impossible.

Mr. Aiken. MR. W. A. AIKEN.—I want to say as chairman of Sub-Committee II on Inspection of Havre de Grace Bridge, that we did a great deal of work attempting to draw up some general description of the different preservative coatings used, so that the public and we might get it in everyday language, but after working over it very hard for a long time and having much correspondence and many meetings, we concluded there was nothing to do except to give the analyses.

Mr. Carpenter. MR. CARPENTER.—Some information that has been given out does not seem to be exactly in accordance with what Mr. Walker and Mr. Aiken have stated. For instance, in the report of Committee E as published in the Proceedings of 1908, it is stated with regard to panel No. 1, that "the pigment consists of oxide of iron, red lead and a carbon black mixed with a varnish containing some gum and thinned with turpentine;" and several other paints were referred to in a similar manner.

Mr. McIlhiney. MR. P. C. MCILHINEY.—These tests, as we all know, were made to find out by practical test what certain paints would do and in submitting them, the manufacturers who made the paints thought they gave us sufficient information as to their composition to enable us to determine the practical behavior of certain kinds of pigments, oils, and paint compositions in actual service. It appears that the amount of information that the manufacturers gave us was for one reason or another inadequate to enable us to draw the general conclusions from the tests that we had hoped. The paint manufacturers who supplied the paints still know what we want to know, and if the committee should go to them, now that the tests are completed, and show them that a large part of the value of the tests will be lost to the world unless they tell us more about the composition of the paints which we have applied, I think they would be willing to give us very much more information, and that we might be able after all to obtain results of practical value from these tests. As the

matter stands now, after six years of work and the expenditure of a great deal of time and money, the practical results to engineers and other users of structural steel are not of very great value. I would suggest, therefore, that further efforts be made by the committee to obtain additional information as to the composition of these paints. Mr. McIlhiney.

The Secretary.—May I offer as an amendment to Mr. Carpenter's motion, that Committee D-1 be charged to renew its efforts in the directions indicated in Mr. Carpenter's motion, and to present a report next year on the results of such renewed efforts? The Secretary.

[This amendment was accepted by the author of the motion and the motion, thus amended, was carried.]

REPORT OF COMMITTEE D-2

ON

STANDARD TESTS FOR LUBRICANTS.

The committee recommends that the tests for lubricants appended to this report be referred to letter ballot of the Society for adoption as "Provisional Tests." The committee has also under consideration recommendations for evaporation, cold test, gumming and emulsification.

Inasmuch as this committee in 1910 reported that:

> "It (the Engler viscosimeter) is the most carefully made and tested instrument; it is also the most easily manipulated and most sensitive,"[1]

it seems well to say that it is the present opinion of the committee that the Saybolt universal viscosimeter is as carefully made and tested, if not more so, than the Engler; that it is much more easily manipulated, and that it is more sensitive.

Other points in favor of the Saybolt universal viscosimeter are as follows:

1. The large ratio of bath volume to test-sample volume, and the small ratio of test-sample area exposed to air, to that in contact with the bath.
2. The automatic adjustment of the quantity of the test-sample as against filling to gage points and the height of column, which also makes for accuracy, the percentage filling errors being inversely as the respective heights.
3. The simple, compressed-air stopper, that does not touch the jet, as against a jet plug which may damage the jet.
4. The gas-heating device is so arranged that there is no chance of its shifting and overheating the outlet jet.
5. It uses for the tests a smaller quantity of oil, and

[1] *Proceedings*, Am. Soc. Test Mats., Vol. X, p. 118 (1910).

tests with it can be carried out in less time and without the necessity of computations, which are unsatisfactory at best.

6. The cleaning with leather-packed plunger in its case, whereas in viscosimeters using gage points, cleaning must be done with some flexible fabric, which is accompanied by the possibility of getting portions of it in the jet, and vitiating subsequent results.

The Saybolt universal viscosimeter is adopted as the standard in manufacturing and selling by the various Standard Oil interests, and by a large majority of the so-called independent refiners in this country.

This report has been submitted to letter ballot of the committee, which consists of 16 members, of whom 8 have voted affirmatively, 3 negatively, and 5 have refrained from voting.

This report is seen to have received the approval of the committee by majority vote of those voting. Certain dissenting members, however, offer a minority report, which is appended to this report.

Respectfully submitted on behalf of the committee,

Augustus H. Gill,
Chairman.

J. M. Jeffers,
Secretary.

[Note.—The proposed Provisional Tests for Lubricants were not referred to letter ballot of the Society. For action taken on the above report, see page 29.

For Discussion on the report, see pages 368–373.—Ed.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED PROVISIONAL TESTS

FOR

LUBRICANTS.

VISCOSITY.

Viscosity shall be determined with the Saybolt universal viscosimeter, the dimensions of which are as follows:

Diameter of overflow filling gage cup	51.0 mm.
Depth of overflow filling gage cup	13.0 "
Diameter of main cylindrical tube	30.0 "
Depth from starting head to outlet jet	113.0 "
Length of outlet jet	13.0 "
Diameter of outlet jet	1.8 "
Charging quantity	70.0 cc.

Tables for the conversion of the readings of other instruments into those of the Saybolt universal viscosimeter are now in preparation by the Bureau of Standards.

SPECIFIC GRAVITY.

For all practical purposes there is little to choose between the hydrometer, Westphal balance, or Geissler pyknometer, provided these instruments are verified. The observations should be taken with the oil at 15°.56 C. (60° F.) and compared with water at the same temperature.

For Beaumé hydrometers, the committee recommends the use of those based on the formula of the Bureau of Standards:

$$\text{Specific Gravity} = \frac{140}{130 + \text{Be.}^\circ\ 60^\circ/60^\circ\ \text{F.}}$$

It should be understood, however, that many Beaumé hydrometers now in use are not based on this formula and in converting the readings of any Beaumé hydrometer to specific gravity care should be taken to use the formula on which the instrument in question is based.

FLASH AND FIRE TEST.

With the Cleveland Open Cup.—The cup is filled to about $\frac{1}{4}$ in. from the top and the thermometer is suspended so that the bulb is just immersed in the oil. The oil is heated at the rate of 10° F. per minute by a Bunsen burner with a protecting chimney; as the flash point is approached, a test is made for every rise of 3° by slowly passing the small bead-like test flame across the cup near the thermometer. The oil should flash near the thermometer when the proper point is reached. The fire test is, as a rule, 50 to 80° F. higher than the flash point. As the open-cup tests are easily affected by drafts, they are subject to errors of 5° F. If the thermometer is graduated to read for total immersion, the stem correction should be applied. When this is done it is suggested that "corr." be added to the reading: thus, "flash 379° F. corr."

Pensky-Martens Test.—Where greater accuracy is required the Pensky-Martens tester should be employed. The method of operating is as follows:[1]

Referring to Fig. 1, E is the oil container, which is placed in a metal heating vessel H, provided with a mantle L in order to protect the heating vessel from loss of heat by radiation. The oil cup E is closed by a tightly fitting lid (shown in plan). Through the center of the lid passes a shaft carrying the stirring arrangement, which is worked by means of the handle J. In another opening of the cover is fixed a thermometer. The lid is perforated with several orifices, which are left open or

[1] Lewkowitsch, "Analysis of Fats, Oils and Waxes," 4th Ed., Vol. 3, p. 58.

covered, as the case may be, by a sliding cover. This can be rotated by turning the vertical spindle by means of the milled head *G*. By turning *G*, an opening of the slide can be made to coincide with an orifice in the cover, and simultaneously a very small flame, burning at the movable jet *L*, is tilted on to the surface of the oil.

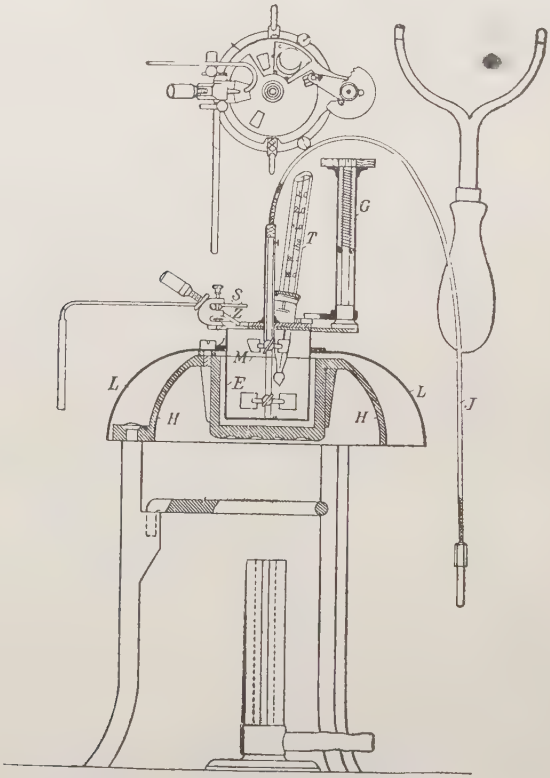


FIG. 1.—Pensky-Martens Tester.

The test is performed by filling the oil into the oil cup up to a certain mark, fixing the cover, and heating the oil somewhat rapidly at first, until its temperature is about 30° C. below the expected flash point. The temperature is then allowed to rise only very slowly, by making suitable use of the wire gauze shown in the figures, so that the rise of temperature within half

a minute does not exceed about 2° C. Every 1°.5 the milled head *G* is turned and the flame tilted into the oil cup. The temperature at which a slight explosion is produced is noted as the flash point of the oil.

SOAP TEST.

The test depends upon the fact that the metaphosphates of the earthy and alkali metals and aluminum are insoluble in absolute alcohol. Five to ten cubic centimeters of the oil are dissolved in 5 cc. of 86° gasoline or ether, and 15 drops of a saturated solution of "stick phosphoric acid" in absolute alcohol are added, shaken and allowed to stand: the formation of a flocculent precipitate indicates the presence of soap. For the accurate determination of these soaps a known quantity of the oil must be ignited and the residue quantitatively examined.

SAPONIFICATION VALUE.

This is expressed by the number of milligrams of potassium hydrate necessary to saponify 1 g. of the oil. From 2.5 to 10 g. of the oil, according as 65 to 20 per cent of saponifiable matter are supposed to be present, are boiled with 25 cc. N/2 alcoholic potash in a 200-cc. Jena Erlenmeyer flask. A reflux condenser is used and the boiling may require from 5 to 8 hours. The excess of alkali is titrated with N/2 HCl, using phenolphthalein. The strength of the N/2 KOH is determined by boiling 25 cc. in similar flasks alongside of those in which the oil is treated and for the same length of time.

Alcohol purified with silver oxide according to Dunlap's method[1] should be used, as well as potassium hydrate "purified by alcohol." For heavy oils, dissolve them in sufficient chemically pure benzol to make a clear solution before adding the potash. Usually 50 cc. will suffice.

FREE ACID.

About 10 g. of oil are weighed into a 200-cc. Jena Erlenmeyer flask, 60 cc. of neutral alcohol added, the mixture

[1] *Journal*, Am. Chem. Soc., Vol. 28, p. 397 (1900).

warmed to about 60° C. and titrated with N/6 KOH, using phenolphthalein, the flask being frequently and thoroughly shaken.

The free acid, if present, should be reported as the number of milligrams of KOH necessary to neutralize the acidity in 1 g. of oil, and the nature of the acid stated if possible.

SULFUR TEST.[1]

Proceed as follows: A portion of a sample, 0.7 to 1.0 g., is burned in a calorimetric bomb containing 10 cc. of water and oxygen under a pressure of 30 atmospheres. A lower pressure sometimes gives inaccurate results. If the sample contains more than 3 per cent of sulfur the bomb is allowed to stand in its water bath for 15 minutes after ignition of the charge. In case the sulfur content is as high as 5 per cent, oxygen under pressure of 40 atmospheres is used. With these high pressures in a Berthelot bomb of 500 to 600-cc. capacity, repeated trials have failed to show even traces of carbon monoxide or sulfur dioxide. If a smaller bomb of about 175-cc. capacity, such as the Peters or Kröker, is used, incomplete combustion from a lack of oxygen may result if too large a sample is taken.

After cooling,—15 minutes is usually enough,—the bomb is opened and its contents are washed into a beaker. If the bomb has a lead washer, 5 cc. of a saturated solution of sodium carbonate are added, the contents are heated to the boiling point, boiled for 10 minutes, and are then filtered. This operation is necessary to decompose any lead sulfate from the washer. The united washings are then filtered, acidified with hydrochloric acid, boiled to expel all carbonic acid, and the sulfuric-acid content is determined in the usual way with barium chloride.

Gravimetric determination is preferred to volumetric, because the nitrogen contained in the air originally in the bomb is oxidized in part to nitroacids, which cause a small error if the volumetric determination alone is used. The sulfur content of any combustible material, from light gasolines weighed in a tared gelatin capsule to solid bitumens and cokes, can be readily determined by this method.

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[1] Allen and Robertson, *Technical Paper No. 36*, Bureau of Mines, p. 10.

This method of burning in a bomb is accurate, practicable, and rapid, and is recommended in preference to all of the other methods there described. The calorimetric determination, if desired, can be made at the same time.

TEST FOR WATER.

Dilute the oil with an equal volume of benzene (C_6H_6), which has been previously saturated with water. Warm to 32° C. Whirl vigorously in a centrifuge until the separated layer of water does not appear to increase in volume.

Alternate Method.—The water content may be determined as follows:

Eighty grams of the sample are weighed into a 250-cc. distilling flask and an equal quantity of xylol or petroleum spirits, having an initial boiling point of about 150° C., is added. The distillation is carried out at the ordinary rate of one drop of distillate per second until 163° C. is reached. In the event of a few drops of water adhering to the condenser and failing to run into the receiver, they may be removed with a weighed pellet of cotton and the amount of water so obtained added to that found in the distillate.

FIG. 2.

PRECIPITATION TEST.

Dissolve 10 cc. of the oil in 90 cc. of 86 to 88° gasoline (from Pennsylvania crude) in the graduated tube[1] shown in Fig. 2. Whirl in centrifuge until no further change in the amount of precipitate is observed.

MICROSCOPICAL EXAMINATION.

Put a few drops of the well-mixed oil on a slide and note the nature of the suspended matter—whether carbonaceous specks, flakes of paraffin which disappear on warming, or foreign matter. Polarized light is a great aid in detecting paraffin

[1] The flat tube originally proposed by Conradson cannot be obtained in the market.

crystals, showing them white on a black background. The polariscope is excellent for this same purpose, showing them when it is impossible to see them with direct light.

CARBON RESIDUE TEST.

T. T. Gray's Method.—To a tared 1-oz. flask of the dimensions shown in Fig. 3, preferably of quartz, add 25 cc. of the oil to be tested and weigh. Wrap the neck of the flask with asbestos paper as far down as the side arm. Stopper tightly

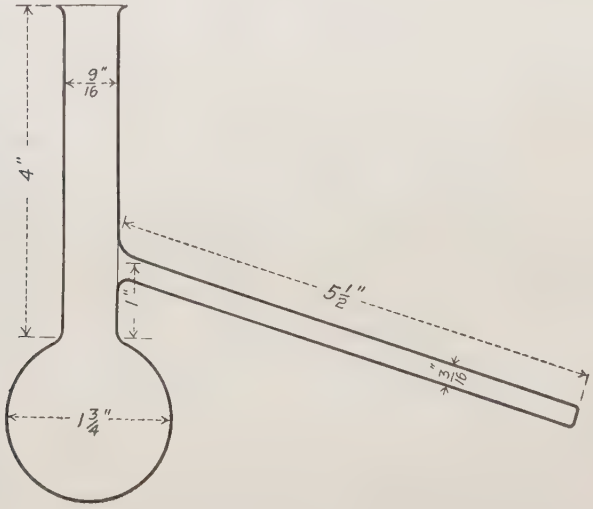

FIG. 3.—"Gray" Carbon Residue Flask.

with a good cork. Connect to a small aerial condenser by plugging the space with asbestos or glass wool. Provide a shield which will protect the flame and the flask up to the side tube. Using the flame of a good Bunsen burner, heat the flask so that the first drop of distillate will come over in approximately five minutes. Continue the distillation at such a rate that one drop per second will fall from the end of the condenser. As the end of the distillation approaches, increase the heat just enough so that no heavy vapors are allowed to condense and drop back into the flask;

continue increasing the heat until the flask is enveloped in the flame, and hold the temperature five minutes. Allow the flask to cool, remove the asbestos covering and cork, and burn out completely the carbon and oil in the neck as far down as the side tube, and in the side tube. Heat the bottom of the flask until no more vapors are given off. Cool and weigh.

MINORITY REPORT.

The undersigned members of Committee D-2, being unable to agree to the omission of certain alternative methods of testing lubricants, beg leave to suggest the following amendment to the majority report:

Viscosity.

As an alternative instrument the Engler viscosimeter[1] either with or without the stirrer and jacketted cover of Ubbelohde is recommended. In case it is desired to correct for the specific gravity of the oil, the following formula which gives results in specific viscosity can be used:

$$\text{Sp. viscosity} = \text{sp. gr.} \times \frac{\text{time of efflux of oil}}{\text{time of efflux of water}} \times 7.32$$

If it is necessary to use a quantity of oil less than 240 cc., the following quantities can be employed and multiplied by the corresponding factor:[2]

Amount of oil put in, cc.....	45	50	60	120
" " run out, cc.....	25	40	50	100
Factor to change to 200 cc. run out and 240 cc. put in	5.55	3.62	2.79	1.65

Table I.—Comparison of Viscosity as Determined by the Engler and Saybolt Viscosimeters.

Sample No.	Engler. 200 cc. of Oil at 68° F.		Engler. 200 cc. of Oil at 100° F.		Saybolt Universal. 60 cc. of Oil at 100° F.		Greater Viscosity by Saybolt, per cent.
	Time of Efflux, seconds.	Viscosity.[1]	Time of Efflux, seconds.	Viscosity.[1]	Time of Efflux, seconds.	Viscosity.[2]	
312.....	106	2.00	79	1.49	49	1.66	11
304.....	304	5.73	146	2.75	101	3.36	29
302.....	666	12.56	260	4.90	182	6.06	23
317.....	852	16.06	319	6.02	223	7.43	23
318.....	1230	23.20	437	8.24	305	10.16	23
306.....	1300	24.53	451	8.51	313	10.43	22
309.....	1765	33.30	574	10.83	399	13.30	22
310.....	2120	40.00	688	12.98	481	16.03	23
Difference between first and last result.	....	.....	...	11.49	...	14.37	..

[1] Compared with 200 cc. of water at 20° C., 53 seconds.
[2] Compared with 60 cc. of water at 100° F., 30 seconds.

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. X, p. 124 (1910).
[2] Gans, *Chemische Revue der Fette und Harz-Industrie*, Vol. 6, p. 221 (1899).

The Engler viscosimeter has been adopted as the standard by the Teutonic and Scandinavian countries, by the United States Government in many Bureaus, and by the International Association for Testing Materials. We feel that it would be a serious mistake for the American Society for Testing Materials not to recognize it as an alternative instrument.

Respectfully submitted,

W. O. Dunbar,
A. H. Gill,
S. W. Stratton.

DISCUSSION.

Mr. Conradson.

MR. P. H. CONRADSON.—As temporary chairman of Committee D-2, I herewith beg to present the report of that committee. In explanation of the minority report I would say that the members signing the majority report are not opposed to an alternate viscosimeter, but they feel that they are not ready to recommend a given instrument to the Society, until they have made further investigations. It may also be mentioned that an improvement has been made in the instrument referred to in the minority report, and that most of the members of the committee feel they should have an opportunity to familiarize themselves with this so-called Ubbelohde improvement. There are, in fact, three distinct improvements over the original Engler viscosimeter which are of considerable value, and we felt we should have further extension of time before we present a report or an alternate viscosimeter.

I may add that the committee consists of 16 members, of whom 8 have voted affirmatively, 3 negatively, and 5 have refrained from voting. I understand that the members signing the minority report, with the explanation given, would not oppose further investigation as regards an alternate instrument as desired by the signers of the majority report.

The Chairman.

THE CHAIRMAN (PRESIDENT A. N. TALBOT).—The Chair understands that the minority report agrees to everything in the majority report, except that it recommends the adoption of an alternate instrument for determining the viscosity. Are any members of the minority present, and do they wish to make a statement further than is contained in their printed report?

Mr. Dunbar.

MR. W. O. DUNBAR.—I think the minority report simply raises the question as to whether the Society wishes to adopt the Saybolt instrument or any other, even provisionally, to the exclusion of every other kind? Otherwise, I agree with the way Mr. Conradson has put it.

The Chairman.

THE CHAIRMAN.—The Chair calls the attention of members to the statement in the minority report, that this other instru-

ment, the Engler instrument, has been adopted as the standard by the Teutonic and Scandinavian countries, by the United States Government in many bureaus, and by the International Association for Testing Materials. What is the wish of the meeting in regard to this matter? The Chairman.

MR. CONRADSON.—I wish to say with reference to that matter, that the point I raised in regard to the minority report is that the original Engler viscosimeter is one thing, and the improved Engler viscosimeter is a different thing, and members of the committee who signed the majority report feel we ought to make further investigations before we come before this Society and recommend the old viscosimeter, which is obsolete, as compared with the improved one. We certainly ought to have the latest and best if we are going to adopt the Engler viscosimeter. It is true that foreign countries, Scandinavia, Germany and Russia, have adopted the Engler instrument, but there are other foreign countries where that instrument has not been adopted, principally England, where the Redwood instrument is the standard. In France the Barby viscosimeter and in Italy the Pagleany type is the standard. The International Association for Testing Materials, so far as I know, has not yet adopted the Engler viscosimeter as a standard, although I may be incorrect about that. If I am correctly informed, there is a question yet between the English and German members of that association as regards the adoption of the Engler instrument. Mr. Conradson.

THE CHAIRMAN.—I suppose the Society would hesitate to decide, when there is a strong minority report as well as a majority report, but the Chair is not sufficiently informed to know whether there would be any serious harm done if action were deferred for another year, until the committee has had an opportunity to investigate all instruments and see whether a further recommendation should be made. Is there any further discussion on this question? The Chairman.

MR. CONRADSON.—There should be no misunderstanding about this. We recommend a standard and the only question is whether an alternate instrument shall be adopted now by the Society as a provisional instrument, or if the Society will agree to refer the minority report back to the committee for further Mr. Conradson.

Mr. Conradson. investigation. The committee as a whole is otherwise in favor of the majority report.

The Secretary. THE SECRETARY.—May I point out that, as I understand it, the minority report has been made in order to indicate that in the judgment of the signers of that report, three in number, whose names are appended—one being the outgoing chairman of the committee, the other, Mr. Dunbar, who is present, and the third being the representative of the Bureau of Standards—the majority report should not be adopted unless coupled with the recommendations contained in the minority report? In other words, they approve of the majority report only with that proviso; otherwise, they disapprove of it.

Mr. Conradson. MR. CONRADSON.—May I say that I am inclined to believe that the statement of the Secretary is correct? Mr. Dunbar can speak for himself, whether, if the minority report be referred back to the committee, with the understanding that further investigation be conducted during the year as regards to an alternate instrument, it will be satisfactory so far as he is concerned.

I may say further that it is rather unfortunate for Committee D-2 that its chairman was not present last year and is not present now, and that I have to stand up here to take his place. However, I am trying to do my best under the circumstances in the interests of the Society. We do not want to adopt anything that is not certain; we do not want to jump at certain conclusions and then take them back next year. Why cannot this question of alternate instrument be referred back to the committee for further investigation, for the reason that there are two instruments, known as the Engler and the Engler-Ubbelohde? The minority report should have stated distinctly one instrument, but not either one of two, because the two instruments are different in practical utility.

Mr. DuComb. MR. W. C. DUCOMB, JR.—Would it not be advisable to refer that part of the report which relates to viscosimeters back to the committee for further consideration and to accept the remainder?

Mr. Conradson. MR. CONRADSON.—I have no objection to that suggestion, because the most important work the committee has done is in connection with the matter of viscosity. The instrument suggested is well known in this country by a great majority of

the producers and consumers. As I stated, also, the signers of the majority report are not opposed to an alternate instrument, but simply want further investigation, and it seems to me that they ought to have the right to complete the report that way. Mr. Conradson.

THE SECRETARY.—Although I know nothing about the technical merits of the question at issue, I am strongly inclined to think that in matters affecting standards, the maxim, "When you're in doubt, don't," is a good one to hold in mind. In the past the Society has sometimes been charged with being too hasty in its action on standards, and although it is to be hoped that the pendulum will not swing back so far that we will become ultra-conservative, we should endeavor, I think, to act with sufficient deliberation. It is not clear that any interests are likely to suffer if the question of standard viscosimeters be held in abeyance for another year. If the majority report alone should be adopted by letter ballot of the Society, the Society would appear to approve of one viscosimeter to the exclusion of all others. After that impression has been once established, it would be a matter of time, after the adoption of an alternate instrument, before it could be removed. The majority and minority are closer together, I think, than may appear on the surface. The majority are willing to make further investigations before recommending an alternate instrument, and the minority are willing to support the majority in that course. I think it wise that the Society should take no action towards the adoption of a standard viscosimeter until the committee is prepared to make a report on its proposed investigations. The Secretary.

MR. C. V. BACON.—I should like to say a word because I think, possibly, the Secretary is not rightly informed. Practically the entire petroleum industry in this country is now using the Saybolt instrument, and while the Engler instrument may be adopted in European countries, if it were adopted in this country, the petroleum manufacturers and the large petroleum consumers would practically have to revise all their methods of purchasing oil, which are at present based on the Saybolt viscosimeter. Mr. Bacon.

THE CHAIRMAN.—There is no motion before us. The Chairman.

MR. C. D. YOUNG.—It would seem to me that in view of the fact that certain members of the committee cannot agree with Mr. Young.

Mr. Young. the majority, it would be well for us to give due consideration to the minority views on the subject. The committee has tried to thresh out the relative merits of the two viscosimeters, and while all agree upon the Saybolt instrument, some members desire the Engler instrument as an alternate. I cannot see what objection there would be to adopting both the majority and minority reports. I therefore move that the minority report as to "Viscosity" be inserted at the end of the section on "Viscosity" in the majority report.

Mr. Mackenzie. MR. K. G. MACKENZIE.—This motion seems to be virtually stating that the Society as a whole has not confidence in its committee; that it more than anticipates the work of the committee in that it does not allow the committee to be sure of its ground before presenting a certain test to the Society, but takes this question of test out of the hands of the committee, although the majority have stated that they do not feel that they are in a position, at the present time, to recommend any alternate instrument, but are considering an alternate instrument and that one will be recommended. It is very essential that some decision on viscosity should be reached as soon as possible, and I cannot see what objection there may be to presenting for letter ballot that part of the report which is agreeable to the members of the committee, with the understanding, which can be stated in the preface to the report, that the committee will at once continue work and recommend, we hope not later than the next meeting, an alternate instrument. I think the last thing we should do is to adopt an instrument which the committee says it does not feel sure should be recommended to the Society.

The Secretary. THE SECRETARY.—I should like to point out that if this motion should prevail it would set aside the recommendations of the majority of the committee. I think it very undesirable to do that. I hope, therefore, that Mr. Young may be moved to withdraw that motion in favor of a motion recommending that both the majority and minority reports be referred back to the committee for further consideration and that in the meantime both be printed in the Proceedings.

Mr. Young. MR. YOUNG.—Yes, I will withdraw my motion with that understanding.

THE SECRETARY.—I offer, then, the motion which I have just stated. The Secretary.

[This motion was carried.]

MR. P. C. MCILHINEY.—In this report there is a description of a test to determine the saponification value, and the method given for making the test is to boil the oil with an alcoholic solution of potash under a return condenser. It so happens that I had occasion some time ago to prepare specifications for an oil in which it was necessary to describe a satisfactory method for determining this saponification value, and I found the procedure outlined here insufficient. It was necessary either to boil down the solution until nearly all the alcohol had evaporated, or else to add benzol to the mixture of oil and alcoholic potash as suggested in a later portion of the paragraph here, but not made obligatory. I think it would be unfortunate to have the method for determining the saponification value remain as it stands. Mr. McIlhiney.

I therefore recommend that the committee give consideration to the following proposed changes in their report:

Insert the words "together with sufficient benzol to give a clear solution" after the words "Erlenmeyer flask" in line 5 of the paragraph entitled "Saponification Value;" also insert the words "is preferable" instead of "should be used" in the second line of the second paragraph, and omit the last two sentences in that paragraph beginning with the words "For heavy oils" and ending with the words "will suffice."

MR. W. B. PRICE.—I should like to corroborate the previous speaker's statement in regard to the saponification value. The very simple expedient of adding 25 cc. of petroleum ether will shorten the time of saponification from five or eight hours to three-quarters of an hour, or even half an hour. I have been able to get a complete saponification of oil in half an hour by adding either petroleum ether or benzol. Mr. Price.

REPORT OF COMMITTEE D-4

ON

STANDARD TESTS FOR ROAD MATERIALS.

Committee D-4 recommends that the following proposed Provisional Tests and Methods for (1) Determination of the Apparent Specific Gravity of Rock, (2) Determination of the Absorption of Water per Cubic Foot of Rock, (3) Making a Mechanical Analysis of Broken Stone or Broken Slag, and (4) Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, appended to this report, be referred to letter ballot of the Society for adoption, and that the subjoined proposed Definitions of Non-Bituminous and Bituminous Road Materials be printed in the Proceedings for one year, as prescribed in the Regulations Governing Technical Committees, and that such Definitions be referred to letter ballot of the Society a year hence.

The committee also recommends that the proposed Standard Definitions contained in its 1913 report[1] and appended hereto be referred to letter ballot of the Society for adoption and added to the "Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements," adopted by the Society on August 5, 1912.[2]

The results of the letter ballot of the committee on the Provisional Tests and Methods are as follows:

Provisional Test or Method.	Affirmative.	Negative.	Not Voting.
Apparent Specific Gravity of Rock	14	1	18
Absorption of Water per Cubic Foot of Rock	15	0	18
Mechanical Analysis of Broken Stone or Broken Slag	11	4	18
Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag	11	4	18

[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, pp. 448–449 (1913).

[2] 1913 Year-Book, p. 299.

After each definition in the following proposed Definitions of Non-Bituminous and Bituminous Road Materials are given the results of the letter ballot of the committee:

Proposed Definitions of Non-Bituminous Road Materials.

Chert.—Compact silicious rock formed of calcedonic or opaline silica, or both.

Affirmative, 12; negative, 3; not voting, 18.

Crusher-Run Stone.—The product of a stone crusher, unscreened except for the removal of the particles smaller than those remaining on a 0.32-cm. ($\frac{1}{8}$-in.) screen.

Affirmative, 11; negative, 4; not voting, 18.

Dust.—Earth or other matter in fine, dry particles, so attenuated that they can be raised and carried by the wind. The product of a rock crusher passing through a fine screen.

Affirmative, 9; negative, 6; not voting, 18.

Flour.—Finely ground rocks or minerals pulverized to an impalpable powder.

Affirmative, 11; negative, 4; not voting, 18.

Granite.—A granitoid igneous rock consisting of quartz, orthoclase, more or less oligoclase, biotite and muscovite.

Affirmative, 11; negative, 3; not voting, 19.

Granitoid.—A textural term to describe those igneous rocks which are entirely composed of recognizable minerals.

Affirmative, 12; negative, 3; not voting, 18.

Matrix.—Material used to bind together the materials in an agglomerated mass.

Affirmative, 12; negative, 3; not voting, 18.

Rubble.—Rough stones of irregular shapes and sizes, broken from larger masses either naturally or artificially, as by geological action, in quarrying, or in stone-cutting or blasting.

Affirmative, 13; negative, 2; not voting, 18.

Soil.—A mixture of fine earthy material with more or less organic matter resulting from the growth and decomposition of vegetation or animal matter.

Affirmative, 13; negative, 2; not voting, 18.

Spawl.—A piece of rock chipped off by a blow of a hammer or other tool.

Affirmative, 10; negative, 5; not voting, 18.

Stone Chips. -Small fragments of stone, irregular in shape, with sharp edges, containing no dust.

Affirmative, 11; negative, 4; not voting, 18.

Tailings.—Stones which after going through the crusher do not pass through the largest openings of the screen.

Affirmative, 13; negative, 2; not voting, 18.

PROPOSED DEFINITIONS OF BITUMINOUS ROAD MATERIALS.

Normal Temperature.—As applied to laboratory observations of the physical characteristics of bituminous materials, is 25° C. (77° F.).

Affirmative, 19; negative, 0; not voting, 14.

Solid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 100 g. applied for 5 seconds, of not more than 10.

Affirmative, 13; negative, 7; not voting, 13.

Liquid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of more than 350.

Affirmative, 15; negative, 5; not voting, 13.

Semi-Solid Bituminous Materials.—Those having a penetration at 25° C. (77° F.), under a load of 100 g. applied for 5 seconds, of more than 10, and a penetration at 25° C. (77° F.), under a load of 50 g. applied for 1 second, of not more than 350.

Affirmative, 14; negative, 6; not voting, 13.

Flux.—Bitumens, generally liquid, used in combination with harder bitumens for the purpose of softening the latter.

Affirmative, 15; negative, 5; not voting, 13.

Asphalt Cement.—A fluxed or unfluxed asphalt specially prepared as to quality and consistency for direct use in the manufacture of bituminous pavements, and having a penetration of between 5 and 250.

Affirmative, 14; negative, 5; not voting, 14.

Straight-Run Pitch.—A pitch run to the consistency desired, in the initial process of distillation, without subsequent fluxing.

Affirmative, 20; negative, 0; not voting, 13.

Native Asphalt.—Asphalt occurring as such in nature, which may contain material of a non-bituminous nature.

Affirmative, 14; negative, 6; not voting, 13.

Consistency.—The degree of solidity or fluidity of bituminous materials.

Affirmative, 17; negative, 1; not voting, 15.

Recommendation that the term "Artificial Asphalt" be discontinued.

Affirmative, 19; negative, 1; not voting, 13.

Recommendation that the term "Road Asphalt" be considered as a trade term which is not subject to definition.

Affirmative, 19; negative, 0; not voting, 14.

Recommendation that the term "Liquid Asphalt" be considered as a trade term which is not subject to definition.

Affirmative, 19; negative, 0; not voting, 14.

This report has been submitted to letter ballot of the committee, which consists of 33 members, of whom 15 have voted affirmatively, 3 negatively, and 15 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. W. PAGE,
Chairman.

PRÉVOST HUBBARD,
Secretary.

[NOTE.—The proposed Provisional Tests, Methods and Standard Definitions accompanying the above report were not referred to letter ballot of the Society. For action taken on the report, see pages 22–23.—ED.]

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED PROVISIONAL TEST

FOR

THE DETERMINATION OF THE APPARENT SPECIFIC GRAVITY OF ROCK.

The apparent specific gravity of rock shall be determined by the following method: First, a sample weighing between 29 and 31 g. and approximately cubical in shape shall be dried in a closed oven for 1 hour at a temperature of 110° C. (230° F.) and then cooled in a desiccator for 1 hour; second, the sample shall be rapidly weighed in air; third, trial weighings in air and in water of another sample of approximately the same size shall be made in order to determine the approximate loss in weight on immersion; fourth, after the balances shall have been set at the calculated weight, the first sample shall be weighed as quickly as practicable in distilled water having a temperature of 25° C. (77° F.); fifth, the apparent specific gravity of the sample shall be calculated by the following formula:

$$\text{Apparent specific gravity} = \frac{W}{W - W_1}$$

in which W = the weight in grams of the sample in air and W_1 = the weight in grams of the sample in water just after immersion.

Finally, the apparent specific gravity of the rock shall be the average of three determinations, made on three different samples according to the method above described.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED PROVISIONAL TEST

FOR

THE DETERMINATION OF THE ABSORPTION OF WATER PER CUBIC FOOT OF ROCK.

The absorption of water per cubic foot of rock shall be determined by the following method: First, a sample weighing between 29 and 31 g. and approximately cubical in shape shall be dried in a closed oven for 1 hour at a temperature of 110° C. (230° F.) and then cooled in a desiccator for 1 hour; second, the sample shall be rapidly weighed in air; third, trial weighings in air and in water of another sample of approximately the same size shall be made in order to determine the approximate loss in weight on immersion; fourth, after the balances shall have been set at the calculated weight, the first sample shall be weighed as quickly as possible in distilled water having a temperature of 25° C. (77° F.); fifth, allow the sample to remain 48 hours in distilled water maintained as nearly as practicable at 25° C. (77° F.) at the termination of which time bring the water to exactly this temperature and weigh the sample while immersed in it; sixth, the number of pounds of water absorbed per cubic foot of the sample shall be calculated by the following formula:

$$\text{Pounds of water absorbed per cubic foot} = \frac{W_2 - W_1}{W - W_1} \times 62.24$$

in which W = the weight in grams of sample in air, W_1 = the weight in grams of sample in water just after immersion, W_2 = the weight in grams of sample in water after 48 hours immersion, and 62.24 = the weight in pounds of a cubic foot of distilled water having a temperature of 25° C. (77° F.).

Finally, the absorption of water per cubic foot of the rock, in pounds, shall be the average of three determinations made on three different samples according to the method above described.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED PROVISIONAL METHOD

FOR

MAKING A MECHANICAL ANALYSIS OF BROKEN STONE OR BROKEN SLAG.

The method shall consist of, first, drying at not over 110° C. (230° F.) to a constant weight a sample weighing in pounds six times the diameter in inches of the largest holes required; second, passing the sample through such of the following sized screens having circular openings as are required or called for by the specification, screens to be used in the order named: 8.89 cm. ($3\frac{1}{2}$ in.), 7.62 cm. (3 in.), 6.35 cm. ($2\frac{1}{2}$ in.), 3.81 cm. ($1\frac{1}{2}$ in.), 3.18 cm. ($1\frac{1}{4}$ in.), 2.54 cm. (1 in.), 1.90 cm. ($\frac{3}{4}$ in.), 1.27 cm. ($\frac{1}{2}$ in.), and 0.64 cm. ($\frac{1}{4}$ in.); third, determining the percentage by weight retained on each screen; fourth, recording the mechanical analysis in the following manner:

Percentage passing	0.64-cm.	($\frac{1}{4}$-in.)	screen	=		
"	"	1.27-cm.	($\frac{1}{2}$-in.)	"	=	
"	"	1.90-cm.	($\frac{3}{4}$-in.)	"	=	
"	"	2.54-cm.	(1-in.)	"	=	
.....	....	...	..	....	...	=
						100.00

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED PROVISIONAL METHOD

FOR

MAKING A MECHANICAL ANALYSIS OF MIXTURES OF SAND OR OTHER FINE MATERIAL WITH BROKEN STONE OR BROKEN SLAG.

The method shall consist of, first, drying at not over 110° C. (230° F.) to a constant weight a sample weighing in pounds six times the diameter in inches of the largest holes required; second, separating the sample by the use of a screen having circular openings 0.64 cm. ($\frac{1}{4}$ in.) in diameter; third, examining the portion retained on the screen in accordance with the proposed Provisional Method for Making a Mechanical Analysis of Broken Stone or Broken Slag, adopted at a meeting of Committee D-4, April 4, 1914; fourth, examining the portion passing this screen in accordance with the "Provisional Method for Sizing and Separating the Aggregate in Asphalt Paving Mixtures" adopted by the American Society for Testing Materials August 21, 1911; fifth, recording the mechanical analysis in the following manner:

Percentage passing 200-mesh sieve	=
" " 100 " "	=
" " 80 " "	=
....	=
Percentage passing 10-mesh sieve	=
" " 0.64-cm. ($\frac{1}{4}$-in.) screen	=
" " 1.27-cm. ($\frac{1}{2}$-in.) "	=
" " 1.90 cm. ($\frac{3}{4}$-in.) "	=
....	=
	100.00

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROPOSED STANDARD DEFINITIONS

OF

TERMS APPLICABLE TO MATERIALS RELATING TO ROADS AND PAVEMENTS.

Asphalts.—Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleum, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt upon the application of heat and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

Asphaltenes.—The components of the bitumen in petroleums, petroleum products, malthas, asphalt cements and solid native bitumens, which are soluble in carbon disulphide but insoluble in paraffin naphthas.

Blown Petroleums.—Semi-solid or solid products produced primarily by the action of air upon originally fluid native bitumens which are heated during the blowing process.

Carbenes.—The components of the bitumen in petroleums, petroleum products, malthas, asphalt cements and solid native bitumens, which are soluble in carbon disulphide but insoluble in carbon tetrachloride.

Cut-back Products.—Petroleum or tar residuums which have been fluxed with distillates.

Tars.—Bitumens which yield pitches upon fractional distillation and which are produced as distillates by the destructive distillation of bitumens, pyrobitumens or organic materials.

Coal Tar.—The mixture of hydrocarbon distillates, mostly unsaturated ring compounds, produced in the destructive distillation of coal.

Coke-oven Tar.—Coal tar produced in by-product coke ovens in the manufacture of coke from bituminous coal.

Dehydrated Tars.—Tars from which all water has been removed.

Gas-house Coal Tar.—Coal tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal.

Oil-gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of oil gas.

Pitches.—Solid residues produced in the evaporation or distillation of bitumens, the term being usually applied to residues obtained from tars.

Refined Tar.—Tar freed from water by evaporation or distillation which is continued until the residue is of desired consistency; or a product produced by fluxing tar residuum with tar distillate.

Water-gas Tars.—Tars produced by cracking oil vapors at high temperatures in the manufacture of carburetted water-gas.

REPORT OF COMMITTEE D-7

ON

STANDARD SPECIFICATIONS FOR TIMBER.

Committee D-7 has held only one meeting during the year. At this meeting the committee organized its work into two general topics, one dealing with specifications for timbers and the other dealing with specifications for preservatives and preservative treatment.

The report which the committee has to make this year is entirely one of progress. Until further specifications are formulated, the committee recommends the continued use of the "Standard Specifications for Yellow-Pine Bridge and Trestle Timbers," adopted in 1910. In doing so, they wish to point out that these specifications apply principally to railway timbers and not to timbers used in buildings. They wish to call specific attention to the fact that when these specifications are used, particular attention should be paid to the clause limiting the percentage of sapwood. Where timbers are exposed to dampness or more or less continuous moist atmosphere, the percentage of sapwood should be as low as possible. The lasting power of timber is usually inversely proportional to the percentage of sapwood contained in any one stick. It is for this reason that the committee limited the percentage of sapwood in all No. 1 grades.

The committee furthermore believes it to be desirable for the consumer to state in his bill of material for what purpose the timbers purchased are to be used. The producer would then be better able to intelligently furnish the material to the advantage of both parties. It is also the belief of the committee that many of the difficulties experienced with structural timbers, particularly from the standpoint of lasting power, have been due to improper use of timbers in locations where their use was not warranted without preservative treatment.

The committee has organized a number of sub-committees, whose duty it will be during the coming year to further investi-

gate the entire question of specifications for timbers, including building timbers, with a view of formulating specifications auxiliary to those already adopted by the Society.

The sub-committees appointed are as follows:

Sub-Committee I on Southern Yellow Pines.—To investigate the best methods for commercially classifying and designating the various species of southern yellow pines.

Sub-Committee II on Uses of Different Grades of Timber.—To investigate and recommend where the different grades of timbers are to be used and to point out the requirements of timbers for certain uses. For example: Mud sills may be full of knots, but should have little sap; stringers in the dry may have sapwood, but are to be relatively free from knots, etc.

The committee believes that the grading of the southern pines for building purposes should be on some other basis than that of botanical nomenclature.

The investigation referring to the use of preservatives has not gone beyond the appointment of a series of sub-committees. It is proposed during the coming year to consider various phases, as follows:

1. Standardization of methods of testing preservatives;
2. Rules for preparing and handling material for treatment;
3. Rules for preparing and handling treated material;
4. Specifications for preservatives;
5. Specifications for preservative treatment;
6. Fireproofing of treated and untreated material;
7. Specifications of timber to be treated;
8. Adaptability of treated material for various purposes;
9. Instructions for the inspection of treated material.

This report has been submitted to letter ballot of the committee, which consists of 27 members, of whom 23 have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

HERMANN VON SCHRENK,
Chairman.

REPORT OF COMMITTEE D-11

ON

STANDARD SPECIFICATIONS FOR RUBBER PRODUCTS.

No meeting of Committee D-11 has been held since the last annual meeting of the Society.

The sub-committees have been active throughout the year in assembling data and drawing up specifications which will be submitted first at a general meeting of the committee to be held at this annual meeting, and then to the Society in 1915.

Sub-Committee I on Air Hose has now under consideration only pneumatic-tool hose.

The organization of Sub-Committee II on Belting has been completed as follows: W. E. Campbell, *Chairman;* J. M. Bierer, A. L. Carter, F. Dannerth, W. C. Geer, J. R. Onderdonk, S. C. Potts, E. B. Tilt.

The following sub-committees have drawn up specifications for products in their field, which will be submitted to the committee for consideration:

Sub-Committee III on Cold-Water Hose;

Sub-Committee V on Insulated Wire—tentative specifications for low-voltage wire;

Sub-Committee VI on Packing, Gaskets and Pump Valves;

Sub Committee VII on Steam Hose.

Sub-Committee IV on Floor Covering has been discontinued for the present.

This report has been submitted to letter ballot of the committee, which consists of 23 members, of whom 19 have voted affirmatively, 3 negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

E. B. Tilt,
Chairman.

E. A. Barrier,
Secretary.

DISCUSSION

Mr. Tilt.

MR. E. B. TILT (*Chairman of Committee D-11*).—It might be well to say a word in explanation of why the report of Committee D-11 happens to be one of promise rather than achievement. The principal reason is that the manufacturer of rubber products to-day seems to take the attitude that all specifications are bad, and we have been trying in a large measure to meet his wishes by being sure of what we are doing before recommending a specification for adoption. Fortunately, within the last year, one of the principal rubber products has been taken out of the hands of the Society. I refer to air-brake hose. We have been left with a number of products, which, while not of great importance as compared with certain other railway products, are yet of prime importance as regards the ease with which they may cause trouble. At the present time, there are a great many people who are making studies, both physical and chemical, of the common commercial rubber products, but there is great difficulty in reconciling the various viewpoints, largely due to different interpretations of results on account of the different manner in which they are obtained. The committee is not large at the present time and those interested in rubber products who desire to have membership, particularly manufacturers, are invited to make their desires known, and we shall include them in so far as it may be possible to do so.

The Secretary.

THE SECRETARY.—May I ask Mr. Tilt to say a word in explanation of why air-brake hose was taken out of the hands of the Society, as he puts it?

Mr. Tilt.

MR. TILT.—I may say in explanation of that, that this is a rubber product which the Master Car Builders' Association probably first took over and covered with specifications, and I believe with satisfactory results. Any specifications that this Society might draw up would necessarily have to be endorsed by the Master Car Builders' Committee, in order to make the hose, bought on such specifications, acceptable for use in inter-

change among railways. Consequently, anything that this committee might do would have to be approved by the Master Car Builders' Association, and we cannot do anything without them in having a specification for this particular material generally adopted, while they can do a great deal without us. Their specification is a very good one and we consider it is better to let it be as it is, rather than make up a new specification which might differ in some details from theirs and which, if the differences are great, would prevent the use of our specification. Mr. Tilt.

THE SECRETARY.—Would it not be well for this committee to recommend the specifications of the Master Car Builders' Association to the Society for adoption so that it may be given a permanent place in our Year-Book? I fancy the Master Car Builders' Association are as liberal minded in such matters as we are, and would therefore not object to having their specifications adopted by other bodies. I would suggest that the committee consider the presentation of these specifications, with such amendments as they may see fit, provided these amendments are acceptable to the Master Car Builders' Association, so that these specifications may be embodied in our Year-Book, if adopted by letter ballot. The Secretary.

MR. TILT.—I shall be very glad to present that viewpoint at the next meeting of the committee and see what the feeling is. I may say that what I have expressed is largely my own opinion as a member of both the Master Car Builders' Committee on specifications and this committee. If I have not made myself clear I wish to add that this Master Car Builders' hose is a product which is confined strictly to cars, and the rules of interchange are such that unless specifications for hose are endorsed by the Master Car Builders' Association, there would practically be no use for such specifications. Those who are using air-brake hose are quite familiar with what the Master Car Builders' Association has done, and their specifications are readily available. However, I shall be glad to draw the matter to the attention of the committee in the way suggested. Mr. Tilt.

MR. S. S. VOORHEES.—I should like to endorse the position taken by the Secretary. I think that our Year-Book and Proceedings should contain as much as possible on the subjects Mr. Voorhees.

Mr. Voorhees considered. We refer to the Proceedings for information, and if this committee can endorse the specifications which have been adopted by the Master Car Builders' Association, it would seem advisable to have these specifications included in the Year-Book.

REPORT OF COMMITTEE E-1

ON

STANDARD METHODS OF TESTING.

Committee E-1 has held two meetings since the date of the Annual Meeting of the Society in June, 1913.

The committee has had a number of subjects under consideration, and has prepared, and proposes for adoption by the Society, the following:

1. Methods for Brinnell hardness tests of metals.
2. An addition to the present Standard Methods for Tension Tests giving the proper dimensions of tension test specimens for metal $\frac{1}{4}$ in. or under in thickness.
3. Certain changes in the present Standard Methods for Tension Tests, regarding the manner of using extensometers when determining the modulus of elasticity, the proportional limit, or the elastic limit.
4. Certain changes in the present Standard Methods for Tension and Compressive Tests, defining correctly proportional limit, elastic limit, and yield point, and correcting those portions of the methods which involve a wrong use of these terms.
5. Miscellaneous minor changes in the present Standard Methods for Tension Tests.
6. A resolution relative to speed of testing.

These are hereby presented in detail.

1. It is recommended that the following proposed Standard Methods for Brinnell Hardness Tests of Metals be added to the Standard Methods of Testing.

Methods for Brinnell Hardness Tests of Metals.

1. Chemical Composition and Heat Treatment of Balls.—(*a*) The chemical composition, as far as carbon and chro-

mium are concerned, should be from 1 to 1.2 per cent of carbon, and from 1 to 1.5 per cent of chromium.

(*b*) The heat treatment should be such as will result in making the balls as hard as possible, consistent with the ability to resist the pressure without cracking or crushing.

While a long series of careful experiments would be needed to justify the specification of more exact conditions in these regards, and while some users of these tests think that the chemical composition (within limits) plays a very small part, if any, in the problem, it is believed that the above requirements will be found satisfactory for commercial work, until such time as suitable experiments shall have furnished the data necessary for making the conditions more precise.

2. Diameter and Form of Balls.—The standard diameter of balls should be 10 mm. The balls should be carefully calibrated before each test to insure that their form is truly spherical, and that the diameter is actually 10 mm. in all directions. The standard diameter should always be employed, except in very rare cases when some other is absolutely necessary.

Thus far there is not sufficient evidence to show that the hardness numbers will be the same when different diameters of balls are used, and some of the evidence indicates that the reverse is the case; hence the importance of adhering to one size of ball.

3. Pressure.—The standard pressures used should be 3000 kg. for steel, and 500 kg. for softer metals. Departure from these pressures should never be tolerated, except in rare cases where it is unavoidable.

The fact that, with our present light on the subject, we can only regard the results as comparative, renders it important to employ as few different pressures as possible.

4. Measurement of Diameter or Depth of Indentation.—Whether the diameter or the depth of the indentation is measured, apparatus should be used that will give results as accurately as a microscope mounted on, and moved by a micrometer screw.

As to the choice between the two there exists a very decided difference of opinion, some thinking one and some the other more conducive to accuracy. The source of error in either case (assuming the measuring apparatus to be accurate) is the depression, or the elevation of the metal immediately surrounding the indentation.

2. It is recommended that the following paragraph be added to present Section 2 of the Standard Methods of Testing, page 307 in the 1913 Year-Book:

> "In the case of flats $\frac{1}{4}$ in. or under in thickness, the dimensions shall be as follows: Width equal to 5 times the thickness of the specimen, except that in no case shall the width be less than $\frac{3}{4}$ in.; gage length equal to 24 times the thickness of the specimen, except that in no case shall the gage length be less than 2 in."

3. It is recommended that the following changes be made in the manner of using extensometers in the Methods for Tension Tests:

(*a*) Strike out Section 6, page 308 in the 1913 Year-Book, namely:

> "6. Within the limits of speed customary in determining the modulus of elasticity, it does not appear that the rate of loading influences the value obtained, but whether this value be determined by an autographic attachment to the machine, or by an extensometer on the specimen, it is desirable that the loading be not too rapid, or not over 0.05 in. per minute, to avoid impairing the accuracy of the sensitive devices employed.",

and substitute the following:

> "6. The standard method of determining the modulus of elasticity should be as follows:
>
> "Attach the extensometer to the specimen at the ends of the gage length—not to the shoulders, nor to any part of the testing machine—and at each end, at points on two opposite sides of the specimen in the case of flats, and at three equidistant points in the case of rounds.
>
> "Stop the machine after each increment or decrement of load long enough to take the readings.
>
> "If it is proposed to determine the modulus of elasticity by means of an extensometer with a continuous motion of the testing machine, by making its speed extremely slow, the speed that can be adopted should be determined in each case by comparison of the results with those obtained by the standard method as described above.
>
> "There is no intention to abolish the use of any extensometer whether it has two or three-point contact, but only to furnish a standard by which the efficiency of any extensometer can be gaged."

(*b*) Strike out Section 7, page 308 in the 1913 Year-Book, namely:

> "7. In determining the modulus of elasticity, the elastic limit (the load at which stress and strain are no longer proportional), and the least load producing a given permanent set, it is considered necessary that the extensometer be attached to two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen.",

and substitute the following:

> "7. In determining the modulus of elasticity, the elastic limit, and the proportional limit, it is considered necessary that the extensometer be attached at each end, in the case of flats, at points on the two opposite sides of the specimen, and in the case of rounds, at three equidistant points, in order to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen; and further, that all tests where the elongations between two successive loads, as measured on the two or three gage lines, differ considerably from each other, shall be rejected."

(*c*) In Section 8, page 308 in the 1913 Year-Book, change "on the two sides of the test piece" to read "on the two opposite sides of the test specimen in the case of flats, and on three equidistant gage lines in the case of rounds."

(*d*) In Paragraph (*c*), page 312 in the 1913 Year-Book, change "on opposite sides of the specimen" to read "on two opposite sides of the specimen in the case of flats, and on three equidistant gage lines in the case of rounds."

4. (*a*) It is recommended that the following section be inserted at the beginning of each of the Methods for Tension and Compression Tests, to be numbered Section 1, the numbering of the other sections being changed successively to correspond:

> "1. *Definition of Terms.*
>
> "*Elastic Limit* is the least load per square inch which produces a permanent set as indicated by an extensometer, using the method hereafter described.
>
> This determination is rarely made in the commercial testing of materials.

"*Proportional Limit* is the load per square inch where stress (load per square inch) and deformation (elongation) per unit of length cease to be proportional to each other, the deformation being determined by an extensometer by the method hereafter described.

This determination is rarely made in the commercial testing of materials.

"*Yield Point* is the load per square inch at which a distinctly visible increase occurs in the distance between the gage marks on the test specimen, as observed by using dividers or an equivalent instrument, or at which, when the load is increased at the rate hereafter specified, there is a distinct drop of the beam of the testing machine.

This determination is made in the commercial testing of materials and is frequently incorrectly expressed as elastic limit.

(*b*) In Section 8, Methods for Compression Tests, line 1, page 313 in the 1913 Year-Book, change "elastic limit" to read "the elastic and also the proportional limit,".

In line 5, strike out the word "elastic."

(*c*) In Sections 10 and 11, page 314 in the 1913 Year-Book, change "elastic limit and yield point" to read "elastic limit, proportional limit and yield point."

5. It is recommended that the following miscellaneous changes be made:

(*a*) In Section 14, Methods for Tension Tests, page 309 in the 1913 Year-Book, change "softer" to read "more ductile".

(*b*) In Section 1, "Conditions to Ensure Correct Testing Machines," page 309 in the 1913 Year-Book, strike out the words "at the Watertown Arsenal."

6. The committee submits the following resolution relative to the speed of testing:

"With reference to Sections 4 and 5, Methods for Tension Tests, page 307 in the 1913 Year-Book, the committee feels that in the light of its recent investigation, the speed of testing, within commercial limits, does affect the

value of the yield point and the ultimate tensile strength, but that until the investigation is complete it cannot make any definite recommendation as to the proper speeds of testing."

Attention is called to the fact that the term "elastic limit" in a sense that should be expressed as "yield point" is used in only five specifications of this Society, of which three are in the hands of Sub-Committee VI on Forgings of Committee A-1 on Standard Specifications for Steel. If the definitions of elastic limit, proportional limit, and yield point proposed by the committee are approved, the term "elastic limit" in these specifications should be changed to read "yield point" in order to harmonize with these definitions.

This report has been submitted to letter ballot of the committee, which consists of 20 members, with the following result: On items Nos. 1, 2 and 5, 14 have voted affirmatively, none negatively, and 6 have refrained from voting; on items Nos. 3, 4 and 6, 13 have voted affirmatively, 1 negatively, and 6 have refrained from voting.

Respectfully submitted on behalf of the committee,

GAETANO LANZA,
Chairman.

[NOTE.—The recommendations contained in the above report were not referred to letter ballot of the Society. For action taken on the report, see pages 27–29. The changes recommended by the committee, which appear on page 28, have been embodied in the report.—ED.]

DISCUSSION

Mr. J. A. Capp.—There are two questions I should like to ask bearing on the report of Committee E-1: Mr. Capp.

1. On the third page of the report, paragraph 2, it is stated that the gage length for flats $\frac{1}{4}$ in. and under in thickness shall be equal to 24 times the thickness of the specimen. Why is there no minimum gage length specified when it is considered that this ruling may be applied to material $\frac{1}{16}$ in. thick, and perhaps even thinner, as in the case of sheet or strip material, which frequently we are called upon to test. Is it the intention of Committee E-1 that the measurement of the elongation in such material shall be limited to a length of a $1\frac{1}{2}$-in. test specimen, being $\frac{3}{4}$ in. wide?

2. It is proposed to modify Section 6, page 308 in the 1913 Year-Book, so that it will be required that the extensometer be attached to rounds at three equidistant points. What is to be done with existing instruments with which very satisfactory results are being obtained, such, for instance, as the Ewing extensometer, the construction of which does not permit of the attachment of the extensometer at three equidistant points? A great deal of experience in using an extensometer of this type shows that results obtained are dependable. It seems rather unfortunate that the report of Committee E-1 should tend to legislate such satisfactory instruments out of existence.

Mr. Henry Hess.—Under Section 2 of the Methods for Brinell Hardness Tests of Metals, on "Diameter and Form of Balls," it is recommended that "the standard diameter of the balls should be 10 mm. The balls should be carefully calibrated before each test to insure that their form is truly spherical . . . in all directions." Mr. Hess.

This recommendation either goes too far or not far enough. It goes too far because it is impossible to procure and impossible to make balls that are "truly spherical in all directions." It does not go far enough because it does not specify a limit of tolerance.

Balls can be procured that do not vary by more than

Mr. Hess. 0.0001 in., plus or minus, of a given dimension, in this case "10 mm. in all directions."

I therefore suggest an amendment to adopt as standard a diameter of ball equal to 10 mm., with a permissible variation of 0.0025 mm. or 0.0001 in., plus or minus; no ball, either new or used, showing a greater variation to be employed.

This permissible variation is entirely feasible, since it is the specification to which balls are furnished in commerical quantities for use in ball bearings of high grade.

Balls for the Brinell test are generally sold at much higher prices than the same balls where sold in quantity for ball bearings. It is quite possible to secure balls having an initial accuracy such as would be indicated by a permissible variation one-half or one-fourth that of the amount suggested. Such balls would be simply selected from among a lot. The only extra cost is therefore that of selection.

Under Section 4, "Measurement of Diameter or Depth of Indentation," the error due to the raising of the metal immediately surrounding the indentation is recognized. In the case of soft metals, this error is large enough to demand recognition. It is, however, quite feasible to eliminate it altogether, as the following method, used by the writer many years ago, will show:

A plate with three hard points spaced about 2 in. apart, equilaterally, was placed on the object to be tested. A slight blow from a hammer at each point gave three indentations. Exactly similar points of the Brinell apparatus were placed into these indentations and a ball depression made under one-tenth normal load. A simple micrometric measuring apparatus, consisting of a plate with three similar locating points and a central micrometer screw, was then used after a small ball of suitable known diameter (3 mm.) was placed in the ball depression. This small ball of itself found the lowest point of depression. The micrometer screw was then brought down in contact with the ball and a reading taken. The Brinell apparatus was then again located by the three points and the ball indentation increased by the application of the full load. The micrometer and small finding ball were then again employed. The difference between the second reading and the first gave the depth of

impression due to the full load. As the first 10-per-cent loading caused a slight compression of the material, the second loading of 100 per cent would cause a depression slightly less than if there had been no initial loading. This is unimportant, however, as the entire method is one of empirical comparison only. Every necessity is complied with so long as all conditions are alike and the method of measurement is the most accurate feasible. Mr. Hess.

Whatever the method of measurement employed to determine the depth of ball indentation, one precaution should always be used: The ball should be measured after each impression. Should it show a change in any dimension of a specified amount, then that test should be rejected and repeated with a new ball.

The following is offered as an amendment to Section 4:

> "Before and after each indentation the diameter of the ball shall be carefully measured not less than four times and along different diameters. The test shall be rejected if the average diameter of the ball should have changed by more than 0.0001 in. or 0.0025 mm. The test shall then be repeated using a new ball."

It would be well to incorporate in the report a caution that in measuring a ball, it should not be handled with the fingers, but placed on a piece of wood and turned by using some instrument, such as tweezers. Even a few moments' contact between a 10-mm. ball and the fingers is quite sufficient to bring about changes of size and shape exceeding the tolerance.

MR. T. D. LYNCH.—I have read the report of Committee E-1 with a great deal of interest. I think we should feel much indebted to Mr. Lanza and the other members of that committee for the careful thought and hard work given to this most important subject. I wish to comment on parts of the report with the thought of adding to it rather than to criticise the ideas brought out by the committee. Mr. Lynch.

Methods for Brinell Hardness Tests of Metals.—1. The specifications recommended for chemical composition and heat treatment of balls seem rather too meager. I should like to see them include either the full chemistry and full heat treatment,

Mr. Lynch. or else some physical test to check the qualities of the finished balls.

2. The diameter and form of balls as recommended, namely, a perfect sphere 10 mm. in diameter, has been found to be quite satisfactory, and instead of making exceptions in rare cases, as recommended by the committee, I wish to recommend that no exceptions be made to the 10-mm. diameter ball.

3. We have used the pressures as recommended by the committee for several years, but have found 500 kg. too heavy for some of the softer metals, and during the past year we have used 200 kg. for metals having a hardness number of 40 or less. We have also found it advantageous to use 3000 kg. on some metals other than steel.

Our study of the subject has led us to believe that the ideal condition is a constant indentation with varying of pressure, but in the absence of a proper apparatus (which we are now considering) for making such records, we have found that very satisfactory results can be obtained by the use of different weights, about as follows:

WEIGHT, KG.	DIAMETER OF INDENTATION, MM.	HARDNESS NUMBER.
3000	2.5 to 4.9	600 to 150
500	2.5 to 3.9	150 to 40
200	2.5 to 5.0	40 to 9.5

Fig. 1 shows curves for Brinell hardness corresponding to various diameters of indentation of ball under pressure of 200, 500 and 3000 kg.

Recommendations Relating to Extensometers.—On the third page of the report, paragraph 3, a proposition is made to strike out Section 6, page 308 of the 1913 Year-Book, and insert a substitute.

I can not quite agree with the recommendation embodied in the report, and wish to say that during the past seven years we have been using a two-point-contact extensometer, and the machine is run continuously until the elastic limit of the test specimen has been exceeded. The results thus obtained, on practically all of the tension tests made in our laboratory during that time, have found favor with our mechanical engineers,

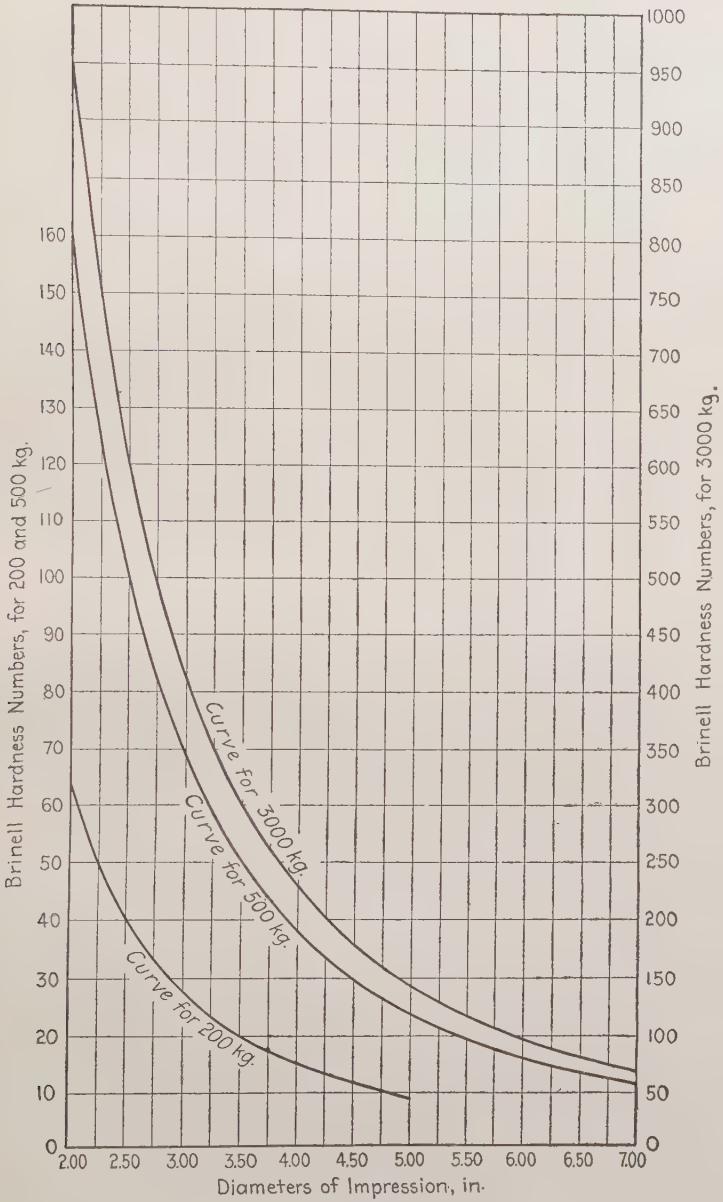

FIG. 1.—Curves for Brinell Hardness.

Mr. Lynch. because the information derived from such tests has proven to be commercial, safe, and accurate within the limits of variation of any two samples of metal from the same bar treated simultaneously.

The method of determining the elastic limit as recommended by the committee requires so much time for each test—about three hours—that it is not commercial, while a two-point contact and continuous running of the machine require only about five minutes for each test, or one-thirty-sixth of the time required by the method recommended by the committee. The results which we have obtained by our method have been of such value to us that we would be very sorry to see this Society adopt a non-commercial method of determining the tensile and elastic properties of materials.

There does not seem to be sufficient evidence to warrant the adoption of a three-point contact as standard, nor the stopping of the machine after each increment or decrement of load.

On the fourth page, paragraph 4 (*a*) of the report, certain recommendations are made, namely:

1. *Definition of Terms.*—"Elastic Limit is the least load per square inch which produces a permanent set as indicated by an extensometer, using the method hereafter described."

Webster's dictionary gives another definition for elastic limit, as follows: "Commercially, in tests of materials of construction, [the elastic limit] is a point at which a large increase of deformation is produced without increase of load."

While the latter definition seems to correspond more closely to the accepted use of the term, it would seem best for us as a national society to go a little slow in adopting the recommendation of the committee at this time.

I would, therefore, recommend that the committee be commended for the good work they have done, and that the report be referred back to them together with the comments brought out at this meeting, and that the committee be requested:

1. To secure comparisons of all the different methods of determining the tensile and elastic properties of materials now being used, and to consider them not only from a purely theoretical point of view, but also from a practical point of view.

2. To review the definition of terms (omitting reference to method of test). Mr. Lynch.

Mr. H. F. Moore (*by letter*).—The changes proposed in Sections 7 and 8, page 308 of the 1913 Year-Book, would require the testing engineer to use two different extensometers for flat and for round test specimens; one with a two-point attachment for flat specimens, and one with a three-point attachment for round specimens. The writer is at a loss to understand why two different extensometers are necessary for the two kinds of specimens, and this proposed change seems to preclude the use of extensometers which are correct in theory and convenient and accurate in use. Mr. Moore.

Any extensometer for determining the modulus of elasticity by means of a tension test, gives correct results only on the supposition that a cross-section of the test specimen which is a plane before stretching is a plane afterward, and that the test specimen is properly centered in the extensometer. So far as the writer can see, for both round and flat specimens either the three-point attachment or the two-point pivoted attachment gives correct results, if the above suppositions are true. The writer has used extensometers with three-point attachment and extensometers with two-point attachment, and has found no greater difficulty in centering two-point extensometers on round specimens than in centering the three-point variety. For each type of instrument, it is the practice in the Laboratory of Applied Mechanics of the University of Illinois to center the test specimen within the framework of the extensometer by means of a template; if extreme accuracy is required two determinations of the modulus of elasticity are made, using the same template in each determination and turning the extensometer 180 degrees around the specimen between the two determinations.

Attention is called to the fact that the proposed changes would bar from use on round specimens, extensometers of the Ewing type and the Martens mirror extensometer as usually constructed. Both of these instruments are generally regarded as instruments of the very highest precision, and both have two points of attachment to the specimen at each end of the gage length.

Mr. Moore. The writer believes that for both round and flat specimens either the two-point or the three-point attachment of extensometer should be allowed, and that attention should be called to the necessity of careful centering of the specimen within the framework of the extensometer, when a determination of the modulus of elasticity is to be made.

Mr. Hunnings. MR. S. V. HUNNINGS.—I wish to ask Mr. Lanza if the committee did not adopt resolutions to the effect that an explanatory clause be inserted in the report stating that the use of the three-point instrument is not absolutely required, but that this instrument is recommended for standardizing any other instrument, or for strictly scientific work.

Mr. Lanza. MR. GAETANO LANZA (*Chairman of Committee E-1*).—We had a meeting of Committee E-1 on Wednesday afternoon, seven members being present. At that time we had before us three written discussions,—one from Mr. Henry Hess, confined wholly to the Brinell Test; another from Mr. T. D. Lynch, which treated of several matters; the third from Mr. J. A. Capp, which treated of two matters. We considered them carefully and adopted the following reply:[1]

1. Regarding the recommendations made in these discussions, concerning the methods for Brinell hardness tests of metals, the following resolution has been adopted by the committee:

"*Resolved*, That, in the opinion of the members present, the various recommendations represent prospective refinements and improvements to be considered in the future reports of the committee, rather than as appropriate for incorporation into our present report, or as justification for delaying the adoption of the report of the committee."

2. Regarding the criticisms on the standard methods of measurement:

The committee has recommended that the following sentence be added to paragraph 6, third page of the report:

"There is no intention to abolish the use of any extensometer, whether it has two or three-point contact, but only to furnish a standard by which the efficiency of any extensometer can be gaged."

[1] This reply also covers the points raised in Mr. H. F. Moore's discussion "by letter."—ED.

3. Regarding the definitions of proportional limit, elastic limit, and yield point, the committee has passed the following resolution: Mr. Lanza.

Resolved, That these definitions are in accord with the best custom of the present day, the first and second agreeing with international usage, and the third with that of the British Standards Committee.

4. Regarding the criticism on the gage length of specimens in the case of material $\frac{1}{4}$ in. thick and under:

The committee has recommended that to paragraph 2, third page of the report, there be added the following clause: "except that in no case shall the gage length be less than 2 in."

I will add that since that time, four other members of the committee signified to me that they approved wholly of the two recommendations, making affirmative votes out of 19.

The Chairman (President A. N. Talbot).—If the Chair may be allowed to comment on this proposal, it seems to make the three-point method the standard. Our own experience has been that in making very accurate determinations of the modulus of elasticity, the two-point extensometer has advantages. We get more consistent results, less variation and more satisfaction in all respects. The three-point instrument is less easy to adjust to center, and that is one of the especially difficult features about this class of testing. It seems to me that specifications for testing should provide what these do not seem to provide, something concerning the relative position of the points along which measurements are to be taken. Personally, I cannot believe that it is wise to make the extensometer with three points of attachment the standard for comparison. The Chairman.

The Secretary.—If I may speak to the report of the committee in a somewhat broad way, it seems to me that it would be well to recognize that the consideration of the criticisms that have been offered has necessarily been limited, in so far as the committee is concerned, to those of its members who happen to be in attendance at this meeting. For that reason, and in view of the desirability of proceeding slowly in the standardization of methods of testing, and the undesirability of having a meeting of this kind pass more or less hastily on matters of a purely scientific nature, it would seem to me wise that we should The Secretary.

The Secretary. content ourselves for the present with the publication in the Proceedings of the report of the committee and this discussion. After the distribution of the Proceedings, and if the committee so desires, the entire membership of the Society might be circularized, with a view of inviting critical comments addressed to the committee by a given date, so that the committee may have the benefit of all such criticisms in the preparation of a report for presentation next year, subject to adoption by the Society, according to the prescribed form of procedure.

I would accordingly move that the report of the committee and the discussion thereon be printed in the Proceedings, and that the subject be referred back to the committee for further consideration.

The Chairman. THE CHAIRMAN.—Would this proposal be agreeable to the committee?

Mr. Lanza. MR. LANZA.—I think that the whole report should be discussed here before any such action is taken.

The report contains six sections, of which the sixth is merely a resolution which apparently does not require action on the part of the Society, so that only the remaining five sections need be considered. It is possible that one of these might be treated differently from another, but it seems to me unnecessary that formal action on the part of the Society on the whole report should be delayed.

The Chairman. THE CHAIRMAN.—Would Mr. Lanza prefer that these items be taken up in order on the motion of the Secretary?

Mr. Lanza. MR. LANZA.—I think so.

The Chairman. THE CHAIRMAN.—The first item then is the recommendation that the proposed standard method of Brinell hardness test of metals be added to the standard methods of testing.

Mr. Fowler. MR. G. L. FOWLER.—If I understand Mr. Lynch's recommendation correctly, it is that the Brinell test shall have a constant impression and that the Brinell figure shall be measured by the weight required to produce that impression. That may be all right for laboratories doing work very carefully and where time is not an important item. To attempt to get the impression down to a certain diameter would require a large number of impressions in trying to get the desired result. As I understand the matter, this would take ten or fifteen times as much time

as now under the ordinary conditions under which Brinell tests are made. It seems to me that for quick commercial work this method is quite impracticable. Mr. Fowler.

MR. LANZA.—I may say that Mr. H. M. Howe knows Mr. Brinell very well and that he sent him a copy of this report for criticism. Mr. Brinell's only criticisms are, first, that he does not consider it at all necessary to measure the diameter of the ball after every test, unless in the case of very hard material; and second, that it is much better to measure the diameter than the depth of the impression. Mr. Lanza.

MR. H. P. TIEMANN.—I might add that that criticism would have an effect on certain export specifications, for example, certain British specifications in which a 20-mm. ball is called for; so it would be better to place no such restriction on the size of the ball to be employed. Mr. Tiemann.

THE CHAIRMAN.—The Chair understands that the Secretary's motion is to have this printed in the Proceedings and to refer it back to the committee applies to this test as well as the others proposed by the committee. It would seem that this is in accordance with the policy of the Society to take time for the consideration of standards of this character. The Chairman.

The motion is to be considered now only in its application to the Brinell test.

THE SECRETARY.—It is evident, or will be, on a moment's consideration, that certain parts of this report will necessarily have to be printed and lie over for a year. I refer especially to the proposed definitions of terms. The policy of the Society is clear on the point that no definitions can be referred to letter ballot for adoption until after they have been in print for a year. The regulations are silent as to the procedure for the adoption of methods of tests as distinguished from specifications. But it would seem that the standardization of methods of tests ought not to be lightly proposed or lightly altered. Such methods are at best only recommendatory, and if they are allowed to lie over for a year, this will embarass no one. With regard to specifications, it may frequently be said with much force that the loss of a year should be avoided, because such products have to be bought in the meantime, and that the proposed specifications, although not ideal, are better than nothing. That argument cannot be The Secretary.

The Secretary. advanced with like force as to methods of tests. If I were a member of this committee, solicitous as I would be to have the methods, when finally promulgated, as nearly puncture-proof as possible, I should be strongly inclined to favor their lying over for a year. I regret to see these matters voted on separately, instead of recognizing the general principle I have tried to enunciate, provided that principle finds acceptance in the minds of those present.

I would accordingly offer the original motion as a blanket motion applicable to the report as a whole, and coupled with the understanding that the membership is to be circularized on this subject in due course as previously suggested.

Mr. Buckingham. MR. F. BUCKINGHAM.—Before this is put, I should like to call attention to the Standard Methods of Testing adopted on August 21, 1911, in relation to the calibration of testing machines. In order to calibrate a machine up to full capacity, it is recommended that a test bar with extensometer attached be used, and one clause in the specification says: "The length of the bar measured by the extensometer shall be sufficient, that the smallest extensometer division will correspond to a difference in the loading of 100 lb. or less." I think you will find that that, in the case of some machines, is an impossible condition, and I would suggest that that clause be referred to the committee with the recommendation that they offer a substitute next year.

Mr. Lanza. MR. LANZA.—That point was called to my attention about eight months ago but I forgot it. I shall be very happy to take it up.

[The Secretary's motion was then carried.]

REPORT OF COMMITTEE E-4

ON

METHODS OF SAMPLING AND ANALYSIS OF COAL.

It will be recalled that Committee E-4 forms part of a joint committee with a committee of the American Chemical Society on Methods of Sampling and Analysis of Coal. Committee E-4 hereby presents its first report to this Society in the form of an appendix containing the second preliminary report of the joint committee, the first preliminary report having been published in the Journal of Industrial and Engineering Chemistry for June, 1913.

This report has been submitted to letter ballot of the committee which consists of 4 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

S. W. PARR,
Chairman.

[For Discussion on this report, see pages 453-455.—ED.]

APPENDIX.

PRELIMINARY REPORT OF THE JOINT COMMITTEE ON COAL ANALYSIS OF THE AMERICAN SOCIETY FOR TESTING MATERIALS AND THE AMERICAN CHEMICAL SOCIETY.

Some time ago committees were appointed by the American Society for Testing Materials and the American Chemical Society for the purpose of revising the standard methods of coal analysis. During the fall of 1911 the two committees were organized as a joint committee consisting of the following members: W. A. Noyes, *Chairman*, Perry Barker, H. C. Dickinson, A. C. Fieldner, Frank Haas, W. F. Hillebrand, S. W. Parr, S. S. Voorhees, A. H. White.

At the Washington meeting of the American Chemical Society in December, 1911, this committee met and after a careful discussion of the problems to be considered appointed the following sub-committees:

I. Preparation of Laboratory Samples, including Loss of Moisture in Sampling—Fieldner, *Chairman*, Haas, Hillebrand, Voorhees, Parr and Barker.

II. Moisture—Hillebrand, *Chairman*, Fieldner, Parr.

III. Deterioration—Parr, *Chairman*, Fieldner, Haas, Dickinson.

IV. Volatile Matter—Parr, *Chairman*, Fieldner, Haas, Dickinson.

V. Fixed Carbon and Ash—Parr, *Chairman*, Fieldner, Hillebrand.

VI. Sulfur—Barker, *Chairman*, Voorhees, Dickinson.

VII. Phosphorus—Hillebrand.

VIII. Ultimate Analysis—Fieldner, *Chairman*, Parr, White.

IX. Calorimetric Determination—Dickinson, *Chairman*, Haas, Barker.

X. Interpretation and Computation—Whole Committee.

After the completion of a large amount of work by the subcommittees and after discussion of the various topics at the Milwaukee meeting of the American Chemical Society in March, 1913, a preliminary report was published in the Journal of Industrial and Engineering Chemistry for June, 1913, page 517. This preliminary report has been the basis for a considerable amount of discussion and correspondence, and the committee now presents a second preliminary report which is to furnish the basis for discussion at the Atlantic City meeting of the American Society for Testing Materials in June, 1914.

This report is intended to give, primarily, those methods of analysis which now commend themselves to the various subcommittees as most suitable. Only such discussion of these methods as seems necessary for their proper understanding and use is included. Additional information upon many of the topics discussed will be found in the first preliminary report referred to above.

Respectfully submitted on behalf of the joint committee,

W. A. NOYES,
Chairman.

REPORT OF SUB-COMMITTEE I ON PREPARATION OF LABORATORY SAMPLES.

Amount and Fineness of Sample for Transmittal to the Laboratory.

Accuracy in reducing gross samples of coal to a quantity convenient for transmittal to the laboratory, is largely dependent on thorough mixing and crushing the extraneous impurities of slate, pyrite, etc., to such a degree of fineness before each quartering or dividing, that the inclusion of a few pieces more or less in the various quarters or divisions cannot materially change the character of the final sample.

A nearly constant ratio between the largest particle of heaviest impurity and the weight of sample is essential in each stage of reduction; otherwise excessive errors are introduced at the particular point in the process where this ratio is exceeded. Hence the quantity of sample to send to the chemist will be governed by the relative proportion of free impurities and the practical limits of fineness to which these impurities can be crushed at the point of sampling. Ordinarily 5 lb. crushed to pass a 4-mesh screen is a convenient sample to send to the laboratory. In cases where it is not feasible to crush to 4-mesh in the field, the weight of the sample sent to the laboratory must conform to the following table:[1]

Size of Largest Impurities, in.	Minimum Weight of Sample, lb.
$\frac{1}{2}$	75
$\frac{3}{8}$	30
$\frac{1}{4}$	9
$\frac{3}{16} - \frac{1}{6}$(4-mesh)[2]	5
$\frac{1}{8}$	3–5

[1] In this table, the ash formed from the largest lump of pyrite is 0.02 per cent of the weight of the sample.

[2] The usual 4-mesh screen has openings of $\frac{3}{16}$ to $\frac{1}{5}$ in. in length.

Special Moisture Samples.

Unless special crushing and sampling apparatus is available, much moisture is lost during the reduction of the gross sample to the smaller sizes given above. Therefore, when the moisture content is important, a special moisture sample should be accumulated by placing in a hermetically sealed receptacle small parts of the freshly taken increments of the gross sample.[1] These parts should be broken to about $\frac{1}{2}$-in. size as accumulated. If possible, the mixing should be done in the closed receptacle, and an average sample of about 3 lb. quickly transferred to a moisture-tight container for shipment to the laboratory.

Mine samples when reduced in the mine do not require a special moisture sample, owing to the usual high humidity of mine atmospheres.

Containers for Shipment to Laboratory.

Samples in which the moisture content is important should always be shipped in moisture-tight containers. A galvanized-iron or tin can with a screw top which is sealed with a rubber gasket and adhesive tape is best adapted to this purpose. Glass fruit jars sealed with rubber gaskets may be used, but require very careful packing to avoid breakage in transit.

Samples in which the moisture content is of no importance need no especial protection from loss of moisture.

Preparation of Laboratory Samples.

The method of preparing a suitable sample for the various analytical determinations that are required in coal analysis must conform as nearly as practicable to the following requirements:

1. A uniform distribution of coal and impurities must be maintained throughout the process of reducing to the final powdered sample. This should be insured by thorough mixing between each dividing or quartering process, and by having due regard to the ratio of size of largest impurities and weight of sample as given in the preceding table.

[1] G. S. Pope, "Sampling Coal Deliveries," *Bulletin No. 63*, Bureau of Mines, p. 29 (1913).

2. Unrecorded changes in moisture during the procedure of sampling must be reduced to a minimum.

Coal, especially when in a pulverized condition, is exceedingly susceptible to change in moisture content. The general tendency is loss of moisture on dividing to finer sizes. This may amount to several per cent in coal that has not been previously air-dried.

The equilibrium point of the moisture in pulverized coal varies with the temperature and humidity of the air. Coal that has reached equilibrium with respect to moisture in an atmosphere of low humidity will reabsorb moisture if placed in an atmosphere of higher humidity.[1]

3. Due regard must be given to the tendency of coal to absorb oxygen and deteriorate in heating value. The time of air-drying must, therefore, be as short as possible and should correspond to the statements given under Method No. 1, below.

METHODS OF SAMPLING.

The following alternate methods of preparing laboratory coal samples are recommended as conforming to the theoretical requirements set forth in the preceding paragraphs, and as being commercially practicable for technical coal analysis:

Method No. 1.—Samples of coal received by the laboratory which exceed 5 lb. in weight, or 4-mesh (length of openings in sieve not to exceed 0.20 in.) in size should be rapidly crushed to 4-mesh, mixed and reduced to not less than 5 lb. This portion is then transferred to a weighed sheet-metal pan, spread out to a depth of 1 in. and at once weighed. The pan is placed in a special drier[2] and the coal allowed to air-dry in circulating air at 10° to 15° C. above the sampling-room temperature, until the rate of moisture loss is less than 0.1 per cent per hour, as shown by two weighings made at intervals of 2 to 4 hours. In most cases Appalachian bituminous coal and anthracite will be

[1] For experimental data on moisture changes in coal samples, see N. W. Lord, "Experimental Work of the Chemical Laboratory," *Bulletin No. 28*, Bureau of Mines, pp. 13–16 (1911).

[2] For details of air-drying oven see Bownocker, Lord and Somermeier, "Coal," *Bulletin No. 9*, 4th Series, Ohio Geological Survey, p. 312 (1908); or F. M. Stanton and A. C. Fieldner, "Methods of Analyzing Coal and Coke," *Technical Paper No. 8*, Bureau of Mines, p. 4 (1912); or E. E. Somermeier, "Coal, Its Composition, Analysis, Utilization and Valuation," p. 71, McGraw-Hill Book Co. (1912).

air-dry if left in the drier over night. Illinois coals may require 48 hours and lignites 72 hours for air-drying.

Immediately after the last weighing has been made, the entire sample should be rapidly pulverized to 10-mesh size, mixed and reduced to 500 g. with an enclosed riffle sampler[1] whose sub-divisions are not more than $\frac{1}{2}$ in. apart. This 500-g. portion is at once transferred to the porcelain jar (8.95 in. in diameter and 9.65 in. high) of an Abbé ball mill, sealed air-tight and pulverized to 60-mesh. Bituminous coals require about $\frac{1}{2}$ hour and anthracites about 2 hours to pulverize to 60-mesh.

The jar should contain about one-third of its volume of 1-in., well-rounded flint pebbles, and should be rotated at about 60 revolutions per minute. The coal is removed from the porcelain jar by emptying the contents on a $\frac{1}{2}$-in. screen, which is vigorously shaken a moment to detach the coal from the pebbles. The sample is then reduced to the final laboratory sample of approximately 60 g. by successively halving it with a small, enclosed riffle sampler. All of the final sample should then be put through the 60-mesh sieve, and at once transferred to a 4-oz. wide-mouthed bottle which is securely closed with a well-fitting rubber stopper. To avoid moisture change the sieve should be covered while sifting. Usually a few particles of coarse material remain on the sieve. These must be rubbed down on a bucking board or mortar to 60-mesh, and thoroughly mixed with the sample. (If one could be certain that all of each sample would pass the 60-mesh sieve it would be preferable to omit sieving, since it has a tendency to segregate the particles of slate and pyrite and offers an opportunity for change in moisture content. On the other hand, if the sieving is omitted there is great danger of rather coarse particles of slate and pyrite being present in the final sample.) The mixing and reducing of the sample after removal from the ball mill should be done rapidly to minimize loss or absorption of moisture. The total time elapsing from the opening of the ball-mill jar to the stoppering of the laboratory sample bottle need not exceed 2 or 3 minutes.

[1] For details of riffle sampler see *Bulletin No. 9*, 4th Series, Ohio Geological Survey, p. 313 (1908); or E. E. Somermeier, "Coal, Its Composition, Analysis, Utilization and Valuation," p. 73, McGraw-Hill Book Co. (1912).

The total loss in weight of samples while air-drying is reported as air-drying loss. The moisture in the coal "as received" = moisture in an air-dried coal $\times \frac{100 - \text{air-drying loss}}{100}$ + air-drying loss.

Method No. 2.—Samples of coal if larger than 4-mesh (0.20 in.) should be rapidly reduced to 5 lb. at 4-mesh or finer as in Method No. 1.

This 5-lb. portion is quickly passed through a suitable crushing apparatus,—rolls or enclosed coffee-mill type of grinder, —adjusted to crush to 10 or 20-mesh size. A 60-g. moisture sample should be taken, without sieving, immediately after the material has passed through the crushing apparatus. This sample should be taken with a spoon from various parts of the 10 or 20-mesh product, and should be placed directly in a rubber-stoppered bottle.

The main portion of the sample is further pulverized until all passes through a 20-mesh sieve. It is then thoroughly mixed and reduced on the riffle to about 120 g., which is pulverized to 60-mesh by any suitable apparatus without regard to loss of moisture. After this sample has been passed through the 60-mesh sieve it is again mixed and divided on a small riffle to 60 g. The final sample should be transferred to a 4-oz. rubber-stoppered bottle.

Moisture is determined at 105° C. on 1-g. portions of the 60-mesh sample and on 5-g. portions of the 20-mesh sample by the method described in this report. In the latter case the drying is continued $1\frac{1}{2}$ hours. The analysis of the 60-mesh coal, which has become partly air-dried during sampling, is calculated to the dry basis by dividing each result by 1 minus its content of moisture. The analysis of the coal "as received" is computed from the "dry-coal" analysis by multiplying by 1 minus the total moisture found in the 20-mesh sample.

Coal containing visible superficial moisture should be spread out in weighed pans and allowed to air-dry as in Method No. 1, or at room temperature; otherwise considerable loss of moisture will take place while crushing to 10-mesh size. The percentage of loss in weight is recorded and the analysis of the

air-dried sample corrected to the "as received" basis, as described in Method No. 1.

Notes on the Two Methods of Sampling.

The first method is preferable for the preparation of laboratory samples that are intended for highly accurate analyses. The unavoidable loss of moisture during sampling is less than by the second method, especially in the case of samples of wet or freshly mined coal. Such samples lose moisture rapidly on exposure to air. Air-drying should not be unnecessarily prolonged, as otherwise an appreciable loss of heating value from oxidation takes place.

The second method can be more readily adapted to the apparatus at hand in the ordinary laboratory, as it does not require the special air-drier or ball mills for pulverizing the coal. The method admits of handling a large number of samples in a short time. The moisture obtained by this method is usually somewhat less than that obtained by the first method. In the case of coals that have lost part of their moisture content through being exposed to the atmosphere, like the usual commercial shipments, this difference need not exceed 0.5 per cent. Wet samples must be partly air-dried.

Coals which are high in sulfur and slate should preferably be pulverized to 80-mesh.

The disk pulverizer is not adapted to the fine grinding of coke and anthracite; the abrasive action of the coke on the iron surface of the disk pulverizer seriously contaminates the sample; and anthracite is heated by the rubbing surfaces to a degree that may change the composition of the sample.

A chipmunk jaw crusher is well adapted to crushing the sample received at the laboratory to 4-mesh size, and a roll crusher for reducing the 4-mesh material to 10 to 20-mesh size. The rolls have one disadvantage, in that with some coals, flakes are formed which must be broken up by rubbing through a sieve before the sample can be reduced on the riffle to quantities less than 500 g. On the other hand, the rolls have a large capacity and are easily cleaned.

Coffee or bone-mill types of grinders may be used for grinding to 10 or 20-mesh size. They should be entirely enclosed and provided with a covered hopper and receptacle of sufficient capacity to hold the entire 5-lb. sample.

A new porcelain-jar ball mill and pebbles should always be tested for abrasion before use. This may be done by grinding 500 g. of sugar for a period of 2 hours, and then determining the ash in the sugar; or by keeping a record of the loss in weight of jar and pebbles and the weight of coal ground.

Allowable Variations.

The accuracy of the method of preparing laboratory samples should be checked frequently by resampling the rejected 10 to 20-mesh portions and preparing a duplicate sample. The ash in

the two samples should not differ more than the following limits:

	Per cent.
No carbonates present	0.4
Carbonates present	0.7
Coals with more than 12 per cent ash, and carbonates present	1.0

Respectfully submitted on behalf of the sub-committee,

A. C. FIELDNER,
Chairman.

REPORT OF SUB-COMMITTEE II ON MOISTURE.

In view of our own experience and that of the chemists who cooperated with a sub-committee of the International Committee on Analyses,[1] it seems needless to strive at present in ordinary work for a very high degree of refinement in the determination of moisture. So sensitive are coals to humidity changes of the air that it is evidently only by chance that two or more analysts will reach the same results for moisture in a given coal, especially if they live in different cities or make the tests on different days in the same place. To the truth of this the report of the above-mentioned International Committee bears abundant testimony. The variations therein shown are probably due, in part, to lack of realization on the part of many of the analysts of the magnitude of the changes in moisture content that may arise during the transfer of the coal from the containing vessel to the drying receptacle and during the weighing operation. Nevertheless, the chances of variation are so serious that the opening statement above is fully justified.

I. Approximate Method.

Use a pair of shallow weighing capsules with ground caps or other well-fitting covers. Suitable forms are indicated below. Heat these under the conditions at which the coal is to be dried, stopper or cover, cool over concentrated sulfuric acid for 30 minutes and weigh.

Dip out with a spoon or spatula from the container two portions of coal of about 1-g. weight each, put these quickly into the drying vessels, close, and weigh at once.

An alternative procedure (more open to error), after transferring an amount slightly in excess of 1 g., is to bring to exactly 1-g. weight (± 0.5 mg.) by quickly removing the excess weight

[1] *Proceedings*, Eighth International Congress of Applied Chemistry, Vol. 25, p. 41 (1912).

of coal with a spatula. The utmost dispatch must be used in order to minimize the exposure of the coal until the weight is found. When the 20-mesh, 5-g. sample is used, it is to be weighed in a similar measure with an accuracy of 2 mg.

Further procedure: Quickly place the vessels open in a preheated oven (at 104 to 110° C.) through which passes a current of air dried by concentrated sulfuric acid. Close the oven at once and heat for 1 hour, or in the case of the 20-mesh, 5-g. sample, for 1½ hours. Then open the oven, cover the capsules quickly and place in a desiccator over concentrated sulfuric acid. When cool, weigh.

NOTES.

1. Although watch glasses ground to fit and with clamp are most effective drying vessels on account of their shallowness, other vessels will be found more convenient. The form that commends itself most, because the ash determination can be made on the moisture sample without transfer, is a porcelain cup of the size and shape represented by No. 1716 in the 1913 catalog of Eimer & Amend and by No. 1338 (No. 2 Royal Meissen Porcelain capsule, ⅞ in. deep and 1¾ in. in diameter) in the catalog of the Scientific Materials Co. of Pittsburgh. At the Bureau of Mines this cup is used with a well-fitting aluminum cover. The cup is 20 to 22 mm. deep and 38 to 40 mm. wide. Glass capsules, as used by S. W. Parr and recommended by the International Committee, are likewise suitable. Those tried at the Bureau of Standards are 15 mm. deep and 25 mm. wide, somewhat shallower than those of Parr. The shallower the drying vessels are, consistent with convenient handling, the quicker and more perfect is the drying. The Parr capsules have the upper part of the wall ground on the outside and the cap is ground on the inside, leaving a smooth edge, a feature which facilitates transfer of the coal to the ashing vessel if the same sample is to be used for determination of the ash.

2. The oven must be so constructed as to have a uniform temperature in all parts and a minimum of air space. The air current must be rapid enough to renew the gas in the oven frequently when the oven holds from six to twelve vessels of coal.

The cylindrical form of oven shown in Technologic Paper No. 8, of the Bureau of Mines, page 5, and holding six crucibles, is well adapted for the purpose; also a new rectangular oven of the same Bureau, holding twelve crucibles and measuring inside 12½ in. high by 4 in. wide and 14½ in. long. The approximate air space in each of these ovens is 0.05 cu. ft. With this type of oven, of small air space, it has been found at the Bureau of Mines that the air must be renewed from two to four times a minute to obtain the maximum loss in weight from the coal in 1 hour.

S. W. Parr uses an oven 12 in. in each of the three directions, and here the renewal of air need not be so rapid, eight to ten times in an hour being probably sufficient.

3. The International Committee in its report recommends, when using air, to remove one of the capsules from the oven at the expiration of 30 minutes, to continue heating the other for 30 minutes longer, and to accept the higher loss in weight, if a difference is shown, as may happen with certain coals. Our committee has not deemed it advisable to prescribe this precaution, both on account of the added labor involved in testing four portions of a sample instead of two and because the probable error in the determination of the true moisture content is so large as to render the precaution of doubtful value. It may, however, serve a useful purpose at times and is a permissible modification of the procedure given in the approximate method. If used, however, a statement to that effect should accompany the report of analysis.

II. Methods of Greater Accuracy.

Method No. 1.—This method is like the approximate method, but instead of air use a current of dry carbon-dioxide gas. After the hour's heating, open the oven, cover the capsules, place them in a vacuum desiccator over concentrated sulfuric acid and exhaust the desiccator. When cool, slowly admit dry air and weigh at once.

Note.—Exhaustion of the desiccator is necessary in order to avoid serious error in weight from the presence of carbon dioxide in the capsules when these are weighed. Although carbon dioxide is absorbed by coal at room temperature there is no absorption above 100° C. Nitrogen gas is to be preferred to carbon dioxide because its density is so near that of air that it will be unnecessary to displace it from the capsules before final weighing. If this gas is used, a vacuum is unnecessary.

Method No. 2.—This method is applicable to the test of only one sample at a time. It is like Method No. 1, but uses a current of dry nitrogen gas and instead of a shallow capsule, a U-tube with well-ground stoppers, and any special form of oven in which the tube can be hung at a temperature of 104 to 110° C. Fill the tube with dry nitrogen before taking its weight empty, and weigh always with a counterpoise tube of about the same displacement and weight. Introduce about a gram of the coal quickly through a short and wide-stem funnel without attempt to secure a weight of exactly 1 g. Before hanging the

tube in the preheated oven pass nitrogen to displace all air, and continuously while heating. When the last trace of moisture has disappeared from the outlet of the tube, remove from the oven and let cool with the gas still passing. When cool close the cocks, hang in the balance case for 15 minutes and after opening one cock weigh with counterpoise. The counterpoise need not be filled with nitrogen.

As a check the water given off may be collected in sulfuric acid and weighed, care being taken to keep the absorption vessel full of nitrogen. The weight of water thus obtained is a little higher than that found indirectly.

Method No. 3.—This method is for use when time does not press. Dry in a vacuum desiccator over sulfuric acid of maximum concentration for 3 and 7 days, longer if necessary.

The vacuum should be high—not over 3 mm. of mercury pressure—and should be checked by a manometer. The capsules mentioned above may be used. Before evacuating, fill the desiccator with an inert gas, and before opening the desiccator carefully let in air dried by sulfuric acid. Weigh immediately.

This method is easy of execution and is sound in principle, since a possible error due to loss of gaseous constituents is negligible. It is important, however, when using a high vacuum, to produce this gradually, since, if suddenly produced before most of the moisture and air have escaped there may be projection of the coal from the capsule.

It has not been deemed advisable to recommend the xylene method of Constam (boiling a large weight of coal with xylene and collecting and measuring the water that distils over) since, though promising, the method has not been subjected to exhaustive test. The same statement applies to a method said to be in use in Germany, which consists in heating the coal in a vacuum at the temperature of boiling alcohol for an hour. So far as tests made at the Bureau of Standards allow of judging, the latter method justifies the claims that have been made for it, and it will be tested further. An article on the subject by P. Schläpfer has been recently published.[1]

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[1] *Zeitschrift für angewandte Chemie.* Vol. 27, p. 52 (1914).

ALLOWABLE VARIATIONS.

	Same Analyst, per cent.	Different Analyst, per cent.
Moisture under 5 per cent.....	0.2	0.3
Moisture over 5 per cent.....	0.3	0.5

Respectfully submitted on behalf of the sub-committee,

W. F. HILLEBRAND,
Chairman.

REPORT OF SUB-COMMITTEE IV ON VOLATILE MATTER.

I. Muffle Method.

It is recommended that for volatile-matter determinations a 10-g. platinum crucible be used having a capsule cover, or one fitting closely enough so that the carbon from bituminous or lignite coals does not burn away from the under side. The capsule cover fits inside of the crucible and not on top. The crucible with 1 g. of coal is placed in a muffle maintained at approximately 950° C. for 7 minutes. With a muffle of the horizontal type, the crucible should not rest on the floor of the muffle but should be supported on a platinum or nichrome triangle bent into a tripod form. After the more rapid discharge of the volatile matter, well shown by the disappearance of the luminous flame, the cover should be tapped lightly to more perfectly seal the crucible and thus guard against the admission of air.

II. Alternate Method.

One gram of coal is placed in a platinum crucible of approximately 20-cc. capacity (35 mm. in diameter at the top and 35 mm. high). The crucible should have a tightly fitting cover, as above. The crucible is placed in the flame of a Mêker burner, size No. 4, having approximately an outside diameter at the top of 25 mm. and giving a flame not less than 15 cm. high. The temperature should be from 900 to 950° C. determined by placing a thermo-couple through the perforated cover, which for this purpose may be of nickel. The junction of the couple should be placed in contact with the center of the bottom of the crucible. Or the temperature may be indicated by the fusion of pure potassium chromate in the covered crucible (fusion of K_2CrO_4, 940° C.). The crucible is placed in the flame about 1 cm. above the top of the burner and the heating is continued for 7 minutes. After the main part of the gases have been discharged the cover should be tapped into place as above described.

When the gas pressure is variable it is well to use a U-tube attachment to the burner to show the pressure.

For lignites a preliminary heating of 5 minutes is carried out, during which time the flame of the burner is played upon the bottom of the crucible in such a manner as to bring about the discharge of volatile matter at a rate not sufficient to cause sparking. After the preliminary heating the crucible is placed in the full burner flame for 7 minutes as above described.

For coke or anthracite a capsule cover or nested crucibles should always be used.

ALLOWABLE VARIATIONS.

	Same Analyst, per cent.	Different Analyst, per cent.
Bituminous coals	0.5	1.0
Lignites	1.0	2.0

Respectfully submitted on behalf of the sub-committee,

S. W. PARR,
Chairman.

REPORT OF SUB-COMMITTEE V ON FIXED CARBON AND ASH.

Determination of Ash.

One gram of coal, either freshly weighed or that which has been used for the moisture determination, is ignited in a shallow porcelain capsule.[1] A low temperature should at first be used, obtained by placing the capsule just above the tip of a Bunsen flame turned down to 2 or 3 in. in height. Frequent stirring with a platinum or nichrome wire is necessary. After a considerable part of the carbon is burned off the flame should be turned up and the heat increased to low redness. The capsule should finally be transferred to a muffle maintained at dull or cherry-red temperature between 700° and 750° C. From 20 to 30 minutes will ordinarily be required for the first part of the process, while 10 minutes should be ample for the heating in the muffle.

If a muffle is used for the whole process, the heating should be started with the muffle cold or on the hearth at a low temperature.

Corrected Ash.

The application of a correction for sulfur present in the iron pyrites depends largely upon the use to be made of the results. For technical purposes it may well be omitted. For comparative purposes, especially where use is to be made of the pure coal or unit values, it should be applied. Five-eighths of the sulfur present in the pyritic form, if added to the ash, would restore the iron sulfide to the original form as weighed.

While with certain types of coal, especially those extensively used for steaming purposes, averaging 15 to 20 per cent ash, it is evident that there is a volatile ash constituent of considerable importance due to hydration of clayey material, in our present state of information as to the uniform distribution of this constituent it does not seem advisable to incorporate it

[1] Such dishes as are listed under the name of "Glüh-Schälchen," No. 5837 in Greiner and Friedrichs catalog, 1912.

in technical analyses. For a comparative study, however, a correction for this type of ingredient cannot be avoided. The factor which has received extended application is an increase of 8 per cent of the ash as weighed to represent this volatile constituent.

Allowable Variations.

	Same Analyst, per cent.	Different Analyst, per cent.
No carbonates present	0.2	0.3
Carbonates present	0.3	0.5
Coals with more than 12 per cent ash	0.5	1.0

Respectfully submitted on behalf of the sub-committee,

S. W. Parr,
Chairman.

REPORT OF SUB-COMMITTEE VI ON SULFUR.

In view of the close agreement of results obtained in the experimental work on various types of coal, the sub-committee recommends that a choice of the following three methods for the determination of sulfur be permissible:

I. The Eschka method;
II. The Atkinson method of fusion with sodium carbonate;
III. The method of fusion with sodium peroxide in the Parr calorimeter bomb.
IV. The washings from the calorimeter bomb, when both parties agree to this method.

I. The Eschka Method.

The essentials of this method as described by G. L. Heath[1] have been modified as given in the former report of the Committee of the American Chemical Society on Coal Analysis.[2] Additional directions for application when city gas is used are also included in the method herein recommended.

Preparation of Sample and Mixture.—Thoroughly mix on glazed paper 1 g. of coal and 3 g. of Eschka mixture. The mixture is prepared by thoroughly incorporating two parts of magnesium oxide with one part of sodium carbonate by passing through a 40-mesh screen. By this method of preparation the mixture attains a uniformity comparable with that of the laboratory sample of coal and thorough incorporation is, therefore, more easily effected.

Transfer to a No. 0 Royal Berlin crucible or platinum crucible of similar size and cover with about 1 g. of Eschka mixture.

Ignition.—On account of the amount of sulfur contained in artificial gas, it is preferable to heat the crucible over an alcohol, gasoline or natural-gas flame or in an electrically heated muffle (procedure (*a*) below). The use of artificial gas for heating the

[1] *Journal*, Am. Chem. Soc., Vol. 20, p. 630 (1898).
[2] *Ibid.*, Vol. 21, p. 1127 (1899).

coal and Eschka mixture is permissible, provided the crucibles are heated in a muffle (procedure (*b*) below).

(*a*) Heat the crucible, placed in a slanting position on a triangle, over a very low flame to avoid rapid expulsion of the volatile matter, which tends to prevent complete absorption of the products of combustion of sulfur. Heat the crucible slowly for 30 minutes, gradually increasing the temperature and occasionally stirring until all black particles disappear, which is an indication of the completeness of the procedure.

(*b*) Place the crucible in a cold gas muffle and gradually raise the temperature to 870 to 925° C. (cherry-red heat) in about one hour. Maintain this maximum temperature for about one and a half hours and then allow the crucible to cool in the muffle.

Subsequent Treatment.—Remove and empty the contents into a 300-cc. beaker and digest with 100 cc. of hot water for one-half to three-quarters of an hour, with occasional stirring. Filter and wash the insoluble matter by decantation. After several washings in this manner, transfer the insoluble matter to the filter and wash five times, keeping the mixture well agitated. Treat the filtrate, amounting to about 250 cc., with 10 to 20 cc. of saturated bromine water, make slightly acid with hydrochloric acid and boil to expel the liberated bromine. Make just neutral to methyl orange with sodium-hydroxide or sodium-carbonate solution, then add 1 cc. of normal HCl. Boil again and add slowly from a pipette with constant stirring 10 cc. of a 10-per-cent solution of barium chloride ($BaCl_2 . 2H_2O$). Continue boiling for 15 minutes and allow to stand for at least 2 hours at a temperature just below boiling. Filter through an ashless filter paper and wash with hot distilled water until a silver-nitrate solution shows no precipitate with a drop of the filtrate. Place the wet filter containing the precipitate of barium sulfate in a weighed platinum or alundum crucible, allowing a free access of air by folding the paper over the precipitate loosely to prevent spattering. Smoke the paper off gradually and at no time allow it to burn with flame. After the paper is practically consumed raise the temperature to approximately 925° C. and heat to constant weight.

The residue of magnesia, etc., after leaching, should be

dissolved in hydrochloric acid and tested with great care for sulfur in combination. When an appreciable amount is found this should be determined quantitatively. The amount of sulfur retained is by no means a negligible quantity.[1]

Blanks and Corrections.—In all cases a correction must be applied either (*a*) by running a "blank" exactly as described above, using the same amounts of all reagents that were employed in the regular determination, or more surely (*b*) by determining a known amount of sulfate added to a solution of the reagents after these have been put through the prescribed series of operations. If this latter procedure is adopted and carried out, say, once a week or whenever a new supply of a reagent must be used, and for a series of solutions covering the range of sulfur content likely to be met with in coals, it is only necessary to add to or subtract from the weight of barium sulfate obtained from a coal whatever deficiency or excess may have been found in the appropriate "check" in order to obtain a result that is more certain to be correct than if a "blank" correction as determined by (*a*) is applied. This is due to the fact that the solubility error for barium sulfate is, for the amounts of sulfur in question and the conditions of precipitation prescribed, probably the largest one to be considered. Barium sulfate is soluble[2] in acids and even in pure water, and the solubility limit is reached almost immediately on contact with the solvent. Hence, in the event of using reagents of very superior quality or of exercising more than ordinary precautions, there may be no apparent "blank," because the solubility limit of the solution for barium sulfate has not been reached or at any rate not exceeded.

A large number of tests using a mixed coal and carburetted water gas containing not more than 25 grains of sulfur per 100 cu. ft. show blanks (determined as under (*a*) above) averaging 3 mg. of barium sulfate.

II. THE ATKINSON METHOD.

Thoroughly mix on glazed paper 1 g. of the laboratory sample of coal with 7 g. of dry sodium carbonate and spread

[1] *Journal*, Am. Chem. Soc., Vol. 21, p. 1128 (1899).

[2] *Ibid*, Vol. 32, p. 588 (1910) and Vol. 33, p. 829 (1911).

evenly over the bottom of a shallow platinum or porcelain dish. Place on a triangle slightly elevated above the bottom of a cold muffle. Raise the temperature of the muffle gradually until a temperature of 650 to 700° C. (dull-red heat) has been obtained in half an hour and maintain this temperature for 10 or 15 minutes. The sodium carbonate should not sinter or fuse. The mixture should not be stirred during the heating process. When the dish has cooled sufficiently to handle, the matter should be examined for black particles of unburned carbon and in case such indications of incompleteness of the process appear, the dish should be replaced and heated for a short time. When all the carbon is burned, remove the dish and digest the contents with 100 to 125 cc., of warm water and 5 cc. of concentrated hydrochloric acid. Allow the insoluble matter to settle, decant through a filter and wash several times by decantation. Transfer to the filter, adding a few drops of a solution of pure sodium chloride, if the insoluble matter tends to pass through the filter. The washing should be continued until the filtrate shows no alkaline reaction. Make the filtrate just acid to methyl orange, add 1 cc. of normal HCl and proceed as described under the Eschka method, with due regard to the correction. No oxidizing agent is required.

III. THE PEROXIDE FUSION METHOD.

This method is most conveniently carried out in the bomb which is a part of the Parr calorimeter,[1] the fusion resulting from a heat determination being especially well suited to this purpose. The charge consists of 0.5 g. of the air-dry laboratory sample of coal, 1 g. of potassium chlorate pulverized to about 20-mesh, and 10 g. by measure of sodium peroxide of the grade regularly prescribed for calorimetric purposes. For mixtures intended only for sulfur determinations, oven-drying is unnecessary. The coal and potassium chlorate are first added to the bomb or fusion cup and thoroughly mixed, being careful to break down any lumps that may form. The sodium peroxide is then added, the container closed and the ingredients thoroughly mixed by shaking.

[1] A simpler, inexpensive bomb is described in *Journal*, Am. Chem. Soc., Vol. 25, p. 184 (1903); see also Noyes, "Organic Chemistry for the Laboratory," p. 21.

After igniting and cooling the charge, dissolve the fusion in a covered beaker, using 150 cc. of water. Add concentrated hydrochloric acid just past the neutral point. This will require from 25 to 30 cc. of acid. Add 1 cc. of concentrated HCl (sp. gr. 1.19) in excess. Filter and wash with hot water, making the final bulk of the solution approximately 250 cc. Heat to boiling and precipitate the sulfate by adding 10 cc. of a hot 10-per-cent solution of barium chloride. Continue the boiling for 15 minutes and allow to stand for at least 2 hours at a temperature just below boiling. Filter, wash and ignite as described under the Eschka method. Particular care should be taken in washing the precipitate obtained by this method in order to remove all of the soluble salts which are formed in the fusion process.

IV. Determination of Sulfur in the Washings from an Oxygen Bomb Calorimeter.

After the combustion, the bomb is washed out thoroughly with distilled water, and the washings collected in a 250-cc. beaker. Six to eight cubic centimeters of dilute (1 : 1) hydrochloric acid containing some bromine water are then added and the solution is heated to boiling. The insoluble matter is filtered off and washed free from sulfates with hot water. The filtrate and washings, which should have a total volume of 200 cc., are made just neutral to methyl orange with sodium-hydroxide or carbonate solution, 1 cc. of normal HCl is added, and the procedure is completed as described under the Eschka method.

Note.

If any odor of SO_2 is detected in the escaping gases from the bomb, the washings cannot be used for the sulfur determination. In such cases a higher oxygen pressure is required. Twenty to twenty-five atmospheres of oxygen is usually sufficient to completely oxidize all sulfur to SO_3 in bombs of 400 to 600-cc. capacity. Some difficulty may be experienced in securing complete oxidation of all sulfur in small bombs of less than 300-cc. capacity. The analyst should in all cases check his results from time to time with the Eschka method.

In general, the sulfur found in the bomb washings is slightly lower (3 to 8 per cent of the total sulfur present) than is obtained by the Eschka method. This may be due (1) to incomplete washing, (2) loss of SO_3, and possibly SO_2

in the gas escaping from the bomb, and (3) retention of sulfur in the coal ash. However, the method is sufficiently accurate for use in the purchase of steaming coal on a B. t. u. basis, and for many similar cases where the precise content of sulfur is not required.

ALLOWABLE VARIATIONS.

	Same Analyst, per cent.	Different Analyst, per cent.
For coal	0.05	0.1
For coke	0.03	0.05

Respectfully submitted on behalf of the sub-committee,

PERRY BARKER,
Chairman.

REPORT OF SUB-COMMITTEE VII ON PHOSPHORUS IN ASH.

Method No. 1. To Cover All Cases.—To the ash from 5 g. of coal in a platinum capsule is added 10 cc. of nitric acid and 3 to 5 cc. of hydrofluoric acid. The liquid is evaporated and the residue fused with 3 g. of sodium carbonate. If unburned carbon is present 0.2 g. of sodium nitrate is mixed with the carbonate. The melt is leached with water and the solution filtered. The residue is ignited, fused with sodium carbonate alone, the melt leached and the solution filtered. The combined filtrates, held in a flask, are just acidified with nitric acid and concentrated to a volume of 100 cc. To the solution, brought to a temperature of 85° C., is added 50 cc. of molybdate solution and the flask is shaken for 10 minutes. The precipitate is washed six times, or until free from acid, with a 2-per-cent solution of potassium nitrate, then returned to the flask and titrated with standard sodium hydroxide solution. The alkali solution may well be made equal to 0.00025 g. phosphorus per cubic centimeter, or 0.005 per cent for a 5-g. sample of coal, and is 0.995 of one-fifth normal.[1] Or the phosphorus in the precipitate is determined by reduction and titration of the molybdenum with permanganate.

Note on Method No. 1.—The advantage of the use of hydrofluoric acid in the initial attack of the ash lies in the resulting removal of silica. Fusion with alkali carbonate is necessary for the elimination of titanium, which if present and not removed will contaminate the phospho-molybdate and is said to sometimes retard its precipitation.

Method No. 2.—When titanium is so low as to offer no objection, the ash is decomposed as under method No. 1, but evaporation is carried only to a volume of about 5 cc. The solution is diluted with water to 30 cc., boiled and filtered. If the washings are turbid they are passed again through the filter. The residue is ignited in a platinum crucible, fused with

[1] Ulmann and Buch, *Chemical Engineer*, Vol. 10, p. 130 (1909).

a little sodium carbonate, the melt dissolved in nitric acid and its solution, if clear, added to the main one. If not clear it is filtered. The subsequent procedure is as under method No. 1. The fusion of the residue may be dispensed with in routine work on a given coal if it is certain that it is free from phosphorus.

Respectfully submitted,

W. F. Hillebrand.

REPORT OF SUB-COMMITTEE VIII ON ULTIMATE ANALYSIS.

Carbon and Hydrogen.

The determination of carbon and of hydrogen is made with a weighed quantity of sample in a 25-burner combustion furnace of the Glaser type. The products of combustion are thoroughly oxidized by being passed over red-hot copper oxide and lead chromate, and are fixed by absorbing the water in a weighed Marchand tube filled with granular calcium chloride ($CaCl_2$) and by absorbing the carbon dioxide in a Liebig bulb containing a 30-per-cent solution of potassium hydroxide (KOH).

The apparatus used consists of a purifying train, in duplicate, a combustion tube in the furnace, and an absorption train. The purifying train consists of the following purifying reagents arranged in order of passage of air and oxygen through them: sulfuric acid, potassium-hydroxide solution, soda lime, and granular calcium chloride. One of the trains is for air and one for oxygen. In the sulfuric-acid and potassium-hydroxide scrubbing bottles the air and the oxygen are made to bubble through about 5 mm. of the purifying reagent. Both purifying trains are connected to the combustion tube by a Y-tube, the joint being made tight by a rubber stopper.

The combustion tube is made of hard Jena glass. Its external diameter is about 21 mm., and its total length is 1 meter. The first 30 cm. of the tube are empty; following this empty space is an asbestos plug (acid-washed and ignited) or in its place a roll of oxidized copper gauze may be used; the next 40 cm. are filled with "wire" copper oxide; a second asbestos plug separates the copper oxide from 10 cm. of fused lead chromate, which is held in place by another asbestos plug 20 cm. from the end of the tube. The end of the tube is drawn out for rubber-tubing connection with the absorption train.

The absorption train consists, first, of a Marchand tube filled with granular calcium chloride ($CaCl_2$) to absorb moisture.

The $CaCl_2$ should be saturated with CO_2 before using. The Marchand tube is followed by a Liebig bulb containing a 30-per-cent potassium-hydroxide (KOH) solution, in which any possible impurities, as ferrous iron or nitrites, have been oxidized by a little potassium permanganate ($KMnO_4$). A guard tube, containing granular calcium chloride and soda lime, is attached to the Liebig bulb to absorb any carbon dioxide escaping the potassium-hydroxide solution and any water evaporating from that solution.

The train is connected to an aspirator which draws the products of combustion through the entire train. A guard tube of calcium chloride prevents moisture from running back into the absorption train. The suction is maintained constant by a Mariotte flask. The advantage of aspirating the gases through the train rather than forcing them through by pressure is that the pressure on the rubber connections is from the outside, so that gas-tight connections are more easily maintained than if the pressure is on the inside of the tube. The connections are made as tight as possible. The usual test for tightness is to start aspiration at the rate of about three bubbles of air per second through the potash bulb, and then to close the inlet for air and oxygen at the opposite end of the train; if there is no more than one bubble per minute in the potash bulb, the apparatus is considered tight.

Before starting a determination when the train has been idle some hours, or after any changes in chemicals or connections, a blank is run by aspirating about 1 liter of air through the train, which is heated in the same manner as if a determination on coal were being made. If the Liebig bulb and the tube containing calcium chloride show a change in weight of less than 0.5 mg. each, the apparatus is in proper condition for use.

A porcelain or platinum boat is provided with a glass weighing tube of suitable size, which is fitted with an accurately ground glass stopper. The tube and empty boat are weighed. Approximately 0.2 g. of the air-dry coal (60-mesh and finer, or better, 100-mesh if much free impurity is present) are quickly placed in the boat. The boat is at once placed in the weighing tube, which is quickly stoppered to prevent moisture change in the coal while weighing, and transferring to the furnace. The

absorption tubes are connected and the boat and sample are transferred from the weighing tube to the combustion tube, which should be cool for the first 30 cm. The copper oxide should be red hot and the lead chromate at a dull-red heat. The transfer of the boat from weighing tube to combustion tube should be made as rapidly as possible. As soon as the boat is in place (near the asbestos plug at the beginning of the copper oxide) the stopper connecting with the purifying train is inserted and the aspiration started with pure oxygen gas at the rate of three bubbles per second. One burner is turned on about 10 cm. back from the boat, and the aspiration is continued carefully until practically all the moisture is expelled from the sample. The heat is then increased very gradually until all the volatile matter has been driven off. In driving off the volatile matter the heat must be applied gradually in order to prevent a too rapid evolution of gas and tar, which may either escape complete combustion or may be driven back into the purifying train. The heat should be slowly increased by turning on more burners under the open part of the tube until the sample is ignited; then the temperature can be increased rapidly, but care should be taken not to melt the combustion tube. Any moisture collecting in the end of the combustion tube or in the rubber connection joining it to the calcium-chloride tube is driven over into the calcium-chloride tube by carefully warming with a piece of hot tile. The aspiration with oxygen is continued for 2 minutes after the sample ceases to glow, the heat is then turned off and about 1200 cc. of air are aspirated. The absorption bulbs are then disconnected, wiped with a clean cloth, and allowed to cool to the balance-room temperature before weighing.

$$\text{Percentage of hydrogen} = \frac{11.19 \times \text{increase in weight of } CaCl_2 \text{ tube}}{\text{Weight of sample}}$$

$$\text{Percentage of carbon} = \frac{27.27 \times \text{increase in weight of KOH bulb}}{\text{Weight of sample.}}$$

The ash in the boat is weighed and carefully inspected for any unburned carbon, which would destroy the value of the determination.

Method with Electrically Heated Combustion Furnace.—An

electrically heated combustion furnace of the Heraeus type is used by the Bureau of Mines.[1]

It consists of three independent heaters, two of which are provided with sheave wheels, and are mounted on a track so that they are movable along the tube; the third heater which surrounds the lead chromate, is stationary.

The furnace as provided by the manufacturer does not include the small stationary heater. This can be made in the laboratory by winding an alundum tube 12 cm. in length with No. 20 nichrome II wire and enclosing it in a cylinder packed with magnesia-asbestos. The movable heaters have very thin platinum foil, weighing about 9 g. in all, wound on a porcelain tube of 30 mm. internal diameter. The larger one which heats the copper oxide, is 350 mm. in length, and the smaller one, which heats the sample in the boat, is 200 mm. in length. The Jena glass or fused silica combustion tube, of about 21 mm. external diameter and 900 mm. in length, is supported by an asbestos-lined nickel trough. The current through each heater is regulated independently by separate rheostats, mounted on the frame of the furnace. The two platinum-wound heaters require an average current of about 4.5 amperes at a pressure of 220 volts, although for heating rapidly a larger amperage is necessary.

The oxygen or air entering the combustion tube is purified by passing through a Tauber's drying apparatus, which contains the following reagents arranged in order of the passage of air or oxygen through them: sulfuric acid, for removing possible traces of ammonia, 30-per-cent potassium-hydroxide (KOH) solution, granular soda lime, and granular calcium chloride. One side of the train is connected directly to a Linde oxygen tank, which is provided with a reducing valve for regulating the oxygen pressure; the other side of the train is used for purifying the air supply.

The absorption train consists of a 5-in. U-tube, filled with granular calcium chloride ($CaCl_2$) to absorb moisture. Before using, the calcium chloride should be saturated with carbon dioxide to avoid possible absorption of carbon dioxide during a

[1] *Technical Paper No. 8*, Bureau of Mines, revised edition 1913, p. 22.

determination by any traces of calcium oxide that may be present. This saturating is done most conveniently by placing a quantity of calcium chloride in a large drying jar, and filling the jar with carbon dioxide. After standing over night, dry air is drawn through the jar to remove the carbon dioxide. The treated calcium chloride is kept in well-stoppered bottles.

The calcium-chloride tube is connected to a Vanier potash bulb containing a 30-per-cent potassium-hydroxide solution and granular calcium chloride. Six to eight determinations can be made without recharging this bulb. The potash bulb is connected to an aspirator through a guard tube containing granular calcium chloride and soda lime, and a Mariotte flask. The Mariotte flask keeps the pressure constant.

In general, the method of determination is the same as the one used with the gas furnace. By moving the heaters toward the end of the tube where the gases enter, and cutting in the electric current, the air can be warmed enough to thoroughly dry the tube and its contents. The current is then cut off from the small heater, and the large heater is moved over the copper oxide; about 250 mm. of that part of the combustion tube between the two heaters where the boat containing the sample is to be placed is kept exposed. The full current is then turned on the large heater to bring the copper oxide to a red heat. When this temperature is reached it is necessary to reduce the current with the rheostat to avoid melting the tube. In the meantime the absorption train is weighed and connected, and the boat containing the sample is placed in the exposed and cooler part of the tube between the two heaters.

The current is then passed through the shorter heater. By manipulating the rheostat and by gradually pushing this heater toward the boat, the rate of evaporation of moisture and evolution of volatile matter can be readily controlled.

After combustion is complete, the electric current is turned off the smaller heater and this heater moved back to allow the tube to cool for the next determination. The final aspiration of air and the weighing of the absorption train is conducted as described under the gas-furnace method.

Note.

In place of granulated $CaCl_2$, concentrated sulfuric acid may be used for collecting the water formed by combustion. In such cases the air and oxygen entering the combustion tube and the gas leaving the potash bulb must also be dried by sulfuric acid.

Other suitable forms of absorption vessels than those indicated in the above procedure may be used.

Nitrogen.

The Kjeldahl-Gunning method is recommended for the determination of nitrogen. This method has the advantage over either the simple Kjeldahl or the Gunning method, in requiring less time for the complete oxidation of the organic matter, and in giving the most uniform results.

The Kjeldahl-Gunning Method.—One gram of the coal sample is boiled with 30 cc. of concentrated sulfuric acid (H_2SO_4), 7 to 10 g. of potassium sulfate (K_2SO_4), and 0.6 to 0.8 g. of metallic mercury in a 500-cc. Kjeldahl flask until all particles of coal are oxidized and the solution nearly colorless. The boiling should be continued at least 2 hours after the solution has reached the straw-colored stage. The total time of digestion will be from 3 to 4 hours. The addition of a few crystals of potassium permanganate ($KMnO_4$), after the solution has cooled enough to avoid violent reaction, tends to insure complete oxidation.

After cooling, the solution is diluted to about 200 cc. with cold water. If the dilution with water has warmed the solution, it should be again cooled and the following reagents added: 25 cc. potassium-sulfide (K_2S) solution (40 g. K_2S per liter) to precipitate the mercury; 1 to 2 g. of granular zinc to prevent bumping; and finally enough strong sodium-hydroxide (NaOH) solution (usually 80 to 100 cc.) to make the solution distinctly alkaline. The danger of loss of ammonia may be minimized by holding the flask in an inclined position while the sodium-hydroxide solution is being added. The alkaline solution runs down the side of the flask and forms a layer below the lighter acid solution. After adding the alkaline solution, the flask is at once connected to the condensing apparatus and the solution mixed by gently shaking the flask.

The ammonia (NH_3) is distilled over into a measured amount (10 cc.) of standard sulfuric-acid solution, to which has been

added sufficient cochineal indicator for titration. Care should be taken that the glass connecting tube on the end of the condenser dips under the surface of the standard acid. The solution is slowly distilled until 150 to 200 cc. of distillate has passed over. To avoid mechanically entrained alkali passing over into the condenser, the rate of distillation should not exceed 100 cc. per hour. The distillate is titrated with standard ammonia solution (20 cc. NH_4OH solution = 10cc. H_2SO_4 solution = 0.05 g. nitrogen). Standard NaOH or KOH solution with methyl orange or methyl red as indicator may be used instead of ammonia and cochineal.

A blank determination should be made in exactly the same manner as described above, except that 1 g. of pure sucrose (cane sugar) is substituted in place of the coal sample. The nitrogen found in this blank determination is deducted from the result obtained with the coal sample.

The potassium sulfide and sodium hydroxide may be dissolved in a single stock solution. Sufficient potassium sulfide is dissolved in the water before adding the sodium hydroxide, to make a solution in which the quantity necessary for a nitrogen determination (80 to 100 cc.) contains 1 g. of potassium sulfide. Twelve grams of potassium sulfide and 500 g. of sodium hydroxide in one liter of water, are required for the above proportions.

Coke and anthracite should be ground to an impalpable powder, as they are very difficult to oxidize. Even if this is done the digestion may require 12 to 16 hours.

Oxygen.

There being no satisfactory direct method of determining oxygen, it is computed by subtracting the sum of the percentages of hydrogen, carbon, nitrogen, sulfur, water and ash from 100. The result so obtained is affected by all the errors incurred in the other determinations and especially by the change in weight of the ash-forming constituents on ignition; iron pyrite changes to ferric oxide, increasing the ash and causing a negative error in the oxygen equivalent to three-eighths of the pyritic sulfur. On the other hand, there is always a loss on ignition, of water of composition from the clayey and shaley constituents, carbon dioxide from carbonates, etc., which tends to compensate the absorption of oxygen.

Corrected Oxygen.—When a more correct oxygen value is desired, it may be obtained by making the corrections indicated in the following formula:

Corrected oxygen $= 100 - [(C - C') + (H - H') + N + H_2O + S' +$ corrected ash].

in which

C = total carbon,
C' = carbon of carbonates,
H = total hydrogen less hydrogen of water,
H' = hydrogen from water of composition in clay, shale, etc.,
N = nitrogen.
H_2O = moisture as found at 105° C.,
S' = sulfur not present as pyrite or sulfate. This is usually small. In many types of coal it may be disregarded.
Corrected ash = mineral constituents originally present in the coal. For most purposes this can be determined with sufficient accuracy by adding to the ash, as found, five-eighths of the weight of pyritic sulfur, the CO_2 of carbonates and the water of composition of clay, shale, etc. See also ash determination.

Respectfully submitted on behalf of the sub-committee,

A. C. FIELDNER,
Chairman.

REPORT OF SUB-COMMITTEE IX ON CALORIMETRIC DETERMINATION.

The specifications are to be of two classes, (*a*) and (*b*). The procedure specified under (*a*) may be followed in tests where a tolerance of at least 1 per cent is allowed. The procedure under (*b*) is to be used in all cases where the limit of tolerance is less than 1 per cent, and is to be followed in all cases of dispute. Under (*b*) any three determinations made at the same time on the same sample may be required to fall within a range of 0.3 per cent.

Combustion Bombs.—The Atwater, Emerson, Mahler, Peters, Williams or similar bombs may be used. For (*a*) the lining material of the bomb need not be specified. The Parr calorimeter may also be used, but only on condition that both parties to the contract agree to its use. For (*b*) the bomb shall have a lining of platinum, gold, porcelain enamel or other material which is not attacked by nitric and sulfuric acids, or other products of combustion.

Calorimeter Jacket.—The calorimeter (except the Parr) must be provided with a water jacket, having a cover to protect the calorimeter from air currents. The jacket must be kept filled with water. For (*b*) the water in the jacket must be kept within 2 or 3° C. of the temperature of the room and should be stirred continuously by some mechanical stirring device.

Stirring of the Calorimeter Water.—The water in the calorimeter must be stirred sufficiently well to give consistent thermometer readings while the temperature is rising rapidly. The speed of stirring should be kept constant. For (*b*) a motor-driven screw or turbine stirrer is recommended and the speed should not be sufficient to hold the temperature of the calorimeter more than 0.3 or 0°.4 C. above that of the jacket, when the stirrer is allowed to run continuously. Accurate results cannot be obtained when too much energy is supplied by the stirring device or when the rate of stirring is too irregular. The portion of the stirring device immersed in the calorimeter should be

separated from that outside by non-conducting material, such as hard rubber, to prevent conduction of heat from the motor or outside air.

Thermometers.—Thermometers used shall have been certified by a government testing bureau and shall be used with the corrections given on the certificate. This shall also apply to electrical resistance or thermo-electric thermometers. For (*b*) correction shall also be made for the temperature of the emergent stem of all mercurial thermometers, and for the "setting" of Beckmann thermometers. For accurate work either Beckmann or special calorimetric thermometers graduated to 0.01 or 0°.02 C. are required. Such thermometers should be tapped lightly just before each reading to avoid errors due to the sticking of the mercury meniscus, particularly, when the temperature is falling. A convenient method is to mount a small electric buzzer directly on the top of the thermometer and connect it up with a dry cell and a push button. The button should be pressed for a few seconds immediately before each reading.

Oxygen.—Oxygen used for combustions shall be free from combustible material and for (*b*) it shall not contain more than 5 per cent nitrogen and argon together. The total amount of oxygen contained in the bomb for a combustion shall not be less than 5 g. per gram of coal. But the combustion must be complete as shown by the absence of any sooty deposit on opening the bomb after firing.

Firing Wire.—The coal in the bomb may be ignited by means of either iron or platinum wire. If iron wire is used, it should be of about No. 34 B. & S. gauge and not more than 10 cm. (preferably 5 cm.) should be used at a time. A correction of 1600 calories per gram weight of iron wire burned is to be subtracted from the observed number of calories. Except, however, that this correction may be omitted from both the standardizations of bomb and coal combustions, provided the same amount of wire is used in all cases.

Standardization.—The water equivalent of a calorimeter can best be determined by the use of the standard combustion samples supplied by the Bureau of Standards. The required water equivalent is equal to the weight of the sample multiplied

by its heat of combustion per gram and divided by the corrected rise in temperature.

The calorimeter shall be standardized by the combustion of standard samples supplied by the Bureau of Standards, and used according to the directions given in the certificates which accompany them. A standardization shall consist of a series of not less than five combustions of either the same, or different standard materials. The conditions as to amount of water, oxygen, firing wire, method of correcting for radiation, etc., under which these combustions are made shall be the same as for coal combustions. For (*b*) in the case of any disagreement between contracting parties a check standardization shall be made at the time of test, but such standardization may consist of two or more combustions of standardizing samples.

Manipulation.

1. *Preparation of Sample.*—The ground sample, which is in approximate moisture equilibrium with the atmosphere, is to be thoroughly mixed in the bottle and an amount, approximately 1 g., is to be taken out and weighed in the crucible in which it is to be burned. Coals which are likely to be blown out of the crucible should be briquetted. Standardizing samples are also to be briquetted. After weighing, the sample should preferably be immediately placed in the bomb and this closed. This procedure is necessary to avoid sublimation when naphthalene is used.

2. *Preparation of the Bomb.*—The firing wire, if iron, should be measured and coiled in a small spiral and connected between the platinum terminals, using, if necessary, a piece of platinum wire somewhat heavier than the iron wire, to make the connection. The platinum and the iron must both be clean. About 0.5 cc. of water should be placed in the bottom of the bomb to saturate, with moisture, the oxygen used for combustion. When the crucible is put in place in the bomb, the firing wire should touch the coal or briquette of standard material. For the combustion of standardizing samples iron wire is preferable to platinum.

3. *Filling the Bomb with Oxygen.*—Oxygen from the supply tank is to be admitted slowly to avoid blowing the coal from the

crucible, and the pressure allowed to reach 20 atmospheres for the larger bombs or about 30 atmospheres for the smaller bombs, so that the bomb shall contain an amount of oxygen sufficient for complete combustion, namely, at least 5 g. per gram of coal, or other combustible. When feasible, the bomb may be exhausted before filling to remove the nitrogen of the air, thus reducing the amount of the nitric acid formed.

4. *Calorimeter Water.*—The calorimeter is to be filled with the required amount of water, depending upon the type of calorimeter. The amount may be determined either by measurement in a standardized flask or by weighing. For (*b*) distilled water should be used and the amount determined by weighing. The amount must be kept the same as that used in standardization of the apparatus, or a correction applied for the difference in weight.

5. *Temperature Adjustments.*—The initial temperature in the calorimeter should be so adjusted that the final temperature, after the combustion, will not be more than 1° C. preferably about 0°.5 C., above that of the jacket, under which conditions the total correction for heat gained from or lost to the surroundings will be small when the rise of temperature is 2 or 3° C. and the effect of evaporation will also be small.

6. *Firing Current.*—The electric current used for firing the charge should be obtained from storage, or dry cells having an electromotive force of not more than 12 volts. The circuit should be closed by means of a switch which should remain closed for not more than 2 seconds. When possible, it is recommended that an ammeter be used in the firing circuit to indicate when the firing wire has burned out. For (*b*) the electromotive force of the firing battery shall not exceed 12 volts, since a higher voltage is liable to cause an arc between the firing terminals, introducing additional heat, which cannot be measured with certainty.

7. *Method of Making an Observation.*—The bomb when ready for firing, is to be placed in the calorimeter, the firing wires connected, the cover put in place and the stirrer and thermometer so placed as not to be in contact with the bomb or container. The stirrer is then started and after the thermometer reading has become steady, not less than 2 minutes after

the stirrer is started, temperatures are read at 1-minute intervals for 5 minutes and the charge is then fired, noting the exact time of firing. Observations of temperature are then made at intervals depending upon the method to be used for computing the cooling correction. When the temperature has reached its maximum and is falling uniformly, a series of thermometer readings is taken at 1-minute intervals for 5 minutes to determine the cooling rate.

8. *Titration.*—After a combustion the bomb is to be opened, after allowing the gas to escape, and the inside examined for traces of unburned material or sooty deposit. If these are found, the observations shall be discarded. If the combustion appears complete, the bomb is to be rinsed out and the washings titrated to determine the amount of acid formed. A correction of 230 calories per gram of nitric acid should be subtracted from the total heat observed. If the sulfur content of the coal is determined, the amount of sulfuric acid should be computed and an *additional* correction of 1220 calories per gram of H_2SO_4 should be subtracted, for the excess of the heat of formation of the sulfuric acid over that of nitric acid.

COMPUTATION OF RESULTS.

The following method of computation is recommended, to take the place of the Pfaundler or other similar formulas for computing the cooling correction (radiation correction).

Observe (1) the rate of rise (r_1) of the calorimeter temperature in degrees per minute for 4 or 5 minutes before firing; (2) the time (a) at which the last temperature reading is made immediately before firing; (3) the time (b) when the rise of temperature has reached six-tenths of its total amount (this point can generally be determined by adding to the temperature observed before firing, 60 per cent of the expected[1] tempera-

[1] When the temperature rise is not approximately known beforehand, it is only necessary to take thermometer readings at 40, 50, 60 seconds (and possibly 70 seconds with some calorimeters) after firing, and from these observations to find when the temperature rise had reached 60 per cent of the total. Thus, if the temperature at firing was 2°.135, at 40 seconds 3°.05, at 50 seconds 3°.92, at 60 seconds 4°.16, and the final temperature were 4°.200, the total rise was 2°.07; 60 per cent of it was 1°.44. The temperature to be observed was then 2°.135+1°.44= 3°.51. Referring to the observations at 40 and 50 seconds, the temperatures were respectively 3.05 and 3°.92. The time corresponding to the temperature of 3°.51 was therefore

$$40+\frac{3.51-3.05}{3.92-3.05}\times 10=45 \text{ seconds.}$$

ture rise, and noting the time when this point is reached); (4) the time (c) of a thermometer reading taken when the temperature change has become uniform some 5 minutes after firing, (5) the final rate of cooling (r_2) in degrees per minute for 5 minutes.

The rate r_1 is to be multiplied by the time $b-a$ in minutes and tenths of a minute, and this product added (subtracted if the temperature was *falling* at the time a) to the thermometer reading taken at the time a. The rate r_2 is to be multiplied by the time $c-b$ and this product added (subtracted if the temperature was *rising* at the time c and later) to the thermometer reading taken at time c. The difference of the two thermometer readings thus corrected, provided the corrections from the certificate have already been applied, gives the total rise of temperature due to the combustion. This multiplied by the water equivalent of the calorimeter gives the total amount of heat liberated. This result, corrected for the heats of formation of nitric and sulfuric acids observed and for the heat of combustion of the firing wire, when that is included, is to be divided by the weight of the charge to find the heat of combustion in calories per gram. Calories per gram multiplied by 1.8 give the British thermal units per pound. (See example.)

The results should be reduced to calories per gram or British thermal units per pound of *dry coal*, the moisture being determined upon a sample taken from the bottle at about the same time as the combustion sample is taken.

For an accurate comparison of coals of different hydrogen content, by means of observation with the combustion bomb, the results which are obtained at constant volume should be reduced to heat of combustion at constant pressure, and to "net" instead of total heat. The former reduction is usually omitted as it is not of great importance; the latter is however of considerable importance as the water formed by the combustion of coal in the bomb is all condensed and its latent heat measured, while in industrial practice the water usually passes off uncondensed and the latent heat is lost. The correction for water condensed may amount to nearly 5 per cent for some bituminous coals while for anthracites and coke it is negligible.

The results of determinations of calorific power shall be

EXAMPLE.

OBSERVATIONS.

Water equivalent = 2550 g.
Weight of charge = 1.0535
Approximate rise of temperature = 3°.2
60 per cent of approximate rise = 1°.9

Time.	Temperature.	Corrected Temperature.
10–21	15°.244 (Thermometer corrections from the certificate)	
22	.250	
23	.255	
24	.261	
25	.266	
(*a*) 26	.272	15°.276
	Charge fired	
(*b*) 27.2	17°.2 [d]	
(*c*) 31	18°.500	18°.497
32	.498	
33	.497	
34	.496	
35	.494	
36	.493	

COMPUTATION.

$r_1 = 0°.028 \div 5 = 0°.0056$ per minute. $b - a = 1.2$ minutes
The corrected initial temperature is
$15°.276 + 0°.0056 \times 1.2 = 15°.283$
$r_2 = 0°.007 \div 5 = 0°.0014$ per minute; $c - b = 3.8$ minutes
The corrected final temperature is $18°.497 + 0.0014 \times 3.8$ ..... = 18°.502
Total rise 18°.502 − 15°.283 ..... = 3°.219
Total calories 2550 × 3.219 ..... = 8209
Titration, etc ..... = −7

Calories from 1.0535 g. coal 8202
Calories per gram 7785

or British thermal units per pound 14013

In practice, the time $b - a$ will be found so nearly constant for a given calorimeter with the usual amounts of fuel that b need be determined only occasionally.

ALLOWABLE VARIATIONS.	Per cent.
Same analyst	0.3
Different analysts	0.4

[d] The initial temperature is 15°.27; 60 per cent of the expected rise is 1°.9. The reading to observe is then 17°.2.

stated either as "total" heat of combustion or "net" heat of combustion.

Total heat of combustion shall refer to results computed as described above.

Net heat of combustion at 20°, shall refer to results computed as follows: The amount of water in grams per gram of coal formed by combustion, multiplied by 580 is to be subtracted from the "total" heat in calories per gram to give the "net" heat in calories per gram, or the amount of water in pounds per pound of coal multiplied by 1040 is to be subtracted from the total heat in British thermal units, to give the net heat in British thermal units, per pound.

Combustion of Anthracites and Coke.

For anthracites and coke, which have a high ash content and do not readily burn completely, the following procedure is recommended:

The inside of the crucible is lined completely with ignited asbestos in a thin layer pressed well down into the angles. The coal is then sprinkled evenly over the surface of the asbestos. Otherwise the procedure is as previously described.

Parr Calorimeter.

The essential conditions for the operation of the Parr or peroxide calorimeter are as follows:

The coal should be finely pulverized. While 60-mesh is sufficient for bituminous coals, anthracites should be ground to at least 100-mesh.

The sodium peroxide used should be received in solder sealed tins and of a size suitable for emptying completely into the container for use, preferably a glass jar with lever sealed cap.

In addition to the reaction the peroxide serves as a diluent and the ratio necessary for a quiet reaction should be maintained, preferably 0.5 g. of coal to approximately 10 g. of peroxide. One gram of pulverized potassium chlorate is also used to advantage. A thorough and uniform mixing with the peroxide is secured by shaking in the closed cartridge.

Coals with moisture above 2 or 3 per cent must be oven-

dried at 110° C. in the usual manner after weighing out, and before mixing with the chemicals.

The correction factors to be subtracted are as follows:

	Deg. Cent.
For each per cent of ash	0.00275
For each per cent of sulfur	0.005
For 1 g. of $KClO_3$	0.130
For electric fuse wire	0.008
For oxygen of bituminous coals for 0.5 g	0.025
For oxygen of brown lignites for 0.5 g	0.050
For oxygen of benzoic acid for 0.5 g	0.124

The products of combustion, CO_2 and H_2O, combine with the chemical with the formation of heat, which amounts in each case to 27 per cent of the total heat of the reaction.

The corrections for ash, fuse wire, etc., in terms of the temperature rise together with radiation and thermometer corrections must first be subtracted from the indicated rise in temperature. The formula for the final calculation then becomes:

$$\frac{\text{Corrected thermometer rise} \times 0.73 \times \text{total water}}{\text{0.5 g. coal}} = \text{calorific value.}$$

Detailed directions for use of the calorimeter accompany each instrument and may be found in numerous handbooks such as White's "Technical Fuel and Gas Analysis," Olsen's "Quantitative Analysis," etc.

Respectfully submitted on behalf of the sub-committee,

H. C. DICKINSON,
Chairman.

DISCUSSION ON THE REPORT OF COMMITTEE E-4.

Mr. E. G. Bailey (*by letter*).—There is a prevalent tendency for chemists to modify methods of analysis to suit their own ideas or whims. Each may think that his particular method has certain advantages or that it is more accurate than any other, and such individual opinions are stubborn obstacles to the settlement of controversies which frequently arise in the purchase of coal. A standard method, definitely and explicitly stated, is the only means whereby such controversies may be settled. It was supposed to be the work of Committee E-4 to draw up such a standard, but the report includes more alternatives and modifications in the methods of making the several determinations than many chemists ever attempted to use. Mr. Bailey.

If a contract for the purchase of coal states that the coal shall be analyzed by the method adopted by this Society, will the contract have to go further and state that the sampling shall be done by method No. 2; the moisture shall be determined by method No. 3 of the Methods of Greater Accuracy; the volatile shall be determined by the alternate method, etc.?

The report of the committee is more of a technical discussion of the subject than a standard method that can be satisfactorily incorporated in contracts for the purchase of coal. For instance, it gives no less than nine different modifications for moisture determination, and each one of these calls for greater refinement than is necessary or desirable in commercial work, considering the small importance of the moisture content. Which one of these modifications is standard? There is no need for standard methods in technical or research work; each chemist will continue to make such analyses in his own way. It is for the commercial testing of coal that the committee was supposed to draw up a method as standard.

The dissertation on sampling is unnecessarily confusing and lacks definiteness. No mention has been made of the effect of the percentage of free impurities upon the size or weight of sample.

Mr. Bailey. From a large amount of experimental work done since the publication of the paper entitled "Accuracy in Sampling Coal," in the Journal of Industrial and Engineering Chemistry, March, 1909, and the bulletin entitled "How to Sample Coal and Coke," in 1910, I have found that the percentage of free impurities has a decided bearing upon the question. The equivalent percentage of free impurities increases with the finer crushing due to their separation from the purer coal, so that in many cases a 5-lb. sample of 4-mesh coal will not result in the degree of accuracy called for in the report.

In reference to the determination of volatile matter, why should a 10-g. crucible be used in the one method and a 20-cc. crucible in the other? Would it not be sufficient to state that a certain weight of coal should be placed in a crucible of a certain size, and heated to a certain temperature for so many minutes, the cover to fit tightly enough to prevent carbon burning away from the lower side of the lid, regardless of whether it is heated over a gas burner, in a muffle, or elsewhere?

The committee apparently does not approve of using the same 1-g. portion of coal in the same crucible for moisture, volatile matter and ash. Such procedure is perhaps more common in commercial work than any other, and has many advantages.

The "frequent stirring" of ash called for is not necessary, nor is it advisable. Many low ash results have been traceable to this cause.

Under the subject of "Calorimetric Determination," mention is made of the "net" heat of combustion. This subject has been fully discussed in journals of the engineering societies. The engineer wants to know the total heating value and is not at all interested in the "net." The latent heat is taken care of by him in the heat balance of a fuel-burning apparatus where all temperatures are known, and any "net" values based upon halfway assumption of the chemist are of no value to any one, and lead only to confusion.

The committee has made no mention of a standard method of determining the fusing temperature of coal ash. This is one of the most valuable determinations in connection with the commercial value of coal, for it and the percentage of ash are of

more importance in arriving at the value of a steam coal from a given region, than all the other determinations combined. Even the heating value is of interest only in connection with test work, in detecting crop coal, or making comparison of one region with another. It is not at all necessary to make calorimetric determinations on contract deliveries. A physical inspection and ash determinations are usually ample protection—supplemented with the fusing temperature of ash where clinker trouble is to be guarded against. Mr. Bailey.

It is to be hoped that Committee E-4 will present a real usable commercial standard in its final report, and that they will omit such alternatives as "the Parr (or peroxide) calorimeter may also be used, but only on condition that both parties to the contract agree to its use." Without any committee report any two parties to a contract may mutually agree to anything they want, but they will look to this committee for a definitely stated standard method that will justly and concisely cover the practical testing of coal purchased on a commercial basis, that will be just and prevent controversies.

Mr. S. W. Parr (*Chairman of Committee E-4, by letter*).— Replying to Mr. Bailey's discussion of the Report of Committee E-4, many of the points referred to have already been brought to the attention of the committee. In view of the fact that the report is preliminary and will not be brought up for final adoption until the next annual meeting, the points raised by Mr. Bailey will be referred to the joint committee for consideration. In all probability that committee will formulate single specifications for contract purposes, such a request having been received from numerous sources. Mr. Parr.

REPORT OF COMMITTEE E-5

ON

REGULATIONS GOVERNING THE FORM BUT NOT THE SUBSTANCE OF SPECIFICATIONS.

Committee E-5 presents as its report this year the Regulations Governing Technical Committees in the revised form in which they appear in the appendix to this report. The italicized parts (except side headings) in this appendix represent new matter. The old matter which has either been cancelled or superseded is shown stricken out, so that all changes in the regulations during the past year are apparent at a glance. The committee is glad to state that no negative vote either on the part of the Executive Committee or Committee E-5 was cast against any of these changes.

This report has been submitted to letter ballot of the committee which consists of 28 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

APPENDIX.

REGULATIONS GOVERNING TECHNICAL COMMITTEES.

NOTE.—By action of the Executive Committee on January 6, 1912, the responsibility for the general Regulations Governing Technical Committees is vested in Committees E-5 on Regulations Governing the Form but not the Substance of Specifications, with the understanding (1) that a proposed change in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

Creation.—The creation of a technical committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

Appointments.—Appointments on technical committees shall be made by the Executive Committee subject to the following provisions:

1. On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of producing and non-producing interests; or the latter may be allowed to predominate with the acquiescence of the former. ~~Unattached experts shall be classed with the representatives of non-producing interests.~~

2. *The classification of the members of a committee into producers and non-producers shall be left to each committee, subject to the following provisions, and with the understanding that a member dissatisfied with his classification has the right of appeal to the Executive Committee:*

   (*a*) *A member who stands in the relation of producer to any product within the province of the committee shall be classed as a producer, although at the request of the officers of the committee concerned, attention shall be called to the status of such members in a footnote worded as follows:*

These members of Committee ..... classed as Producers, stand in the relation of Producers to certain products, and in that of Non-Producers to other products within the province of the committee.

(*b*) *A nominally unattached expert, who is permanently retained by producing interests in the field of activities of the committee with which he is connected, shall be classed as a producer.*

3. *Only one representative from a given firm, company, corporation, laboratory, or other institution shall be eligible on a given committee, but if that membership is held in the name of the firm, company, corporation, laboratory, or other institution, more than one representative may, at the discretion of the committee concerned, participate in its activities, with the understanding that such representatives shall jointly command only a single vote. In the case of corporations or government branches whose policy does not admit of their holding membership in the Society under their corporate or official name, an exception to this rule may be permitted at the discretion of the committee concerned.*

4. Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.

5. Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

Preliminary Organization.—The President of the Society will appoint the chairman *pro tem.* of a new committee from the representatives of the non-producing interests and unattached experts. The chairman *pro tem.*, after communicating with the other members of the committee, will fix the place and time of the first meeting. He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to econ-

omize time at the meeting and to afford a definite basis for discussion.

Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of non-producing interests and unattached experts, and such other officers and sub-committees as the committee may desire. The duties and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

Election of Officers.—Every technical committee shall hold an election of officers at or before the 1914 annual meeting of the Society. The term of office of every officer shall be two years and officers shall be eligible for re-election.

Reports.—The reports of technical committees shall be presented at the annual meetings. ~~Reports embodying any features on which specific action on the part of the Society is recommended by the committee, must first have been submitted to letter ballot of the committee, and such features must have received the approval of the majority of those voting~~. *Such reports must first have been submitted to letter ballot of the committee and must have received the approval of the majority of those voting. A statement of the following form shall appear at the close of every committee report:*

This report has been submitted to letter ballot of the committee which consists of ..... members, of whom ..... have voted affirmatively, ... negatively, and ..... have refrained from voting.

Dissenting members shall have the right to present minority reports individually or jointly.

Specifications.—Proposed new standard specifications or the proposed amendment of existing standard specifications must originate in the particular committee within whose province such specifications properly belong. No action affecting specifications shall be taken by any technical committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the

entire committee. *The results of each letter ballot as to the number of affirmative votes, the number of negative votes, and the number of members not voting, shall be announced in the report of the committee to the Society.* Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendations affecting specifications must be transmitted to the Secretary of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter.

Any recommendations affecting specifications presented by the appropriate committees at the annual meeting of the Society may be amended as prescribed in the by-laws and the final adoption of new or amended specifications shall be subject to the following procedure, also prescribed in the by-laws:

1. Approval at an annual meeting by two-thirds vote of those voting;
2. Approval by letter ballot of the Society by two-thirds vote of those voting.

Definitions.—The procedure governing action on proposed new standard definitions or proposed amendment of existing standard definitions shall be in precise conformity with that above defined in relation to "Specifications," except that, as prescribed in the by-laws, such new or amended definitions shall not be referred to letter ballot of the Society prior to the annual meeting following their publication in the Proceedings.

Cooperation with Other Committees.—A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.

A committee desiring to bring about the appointment of similar committees by other societies for purposes of cooperation shall address a recommendation to that effect to the Executive Committee and, on the approval of the latter, negotiations to the desired end shall be conducted on behalf of the Executive Committee by the Secretary of the Society.

Publication.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

~~*Current Expenses.*—The current expenses of committees for stationery and postage will be assumed by the Society. Stationery of standard form will be furnished by the Secretary of the Society on application of the chairman or secretary of a committee. Expenses for postage will be paid by the Treasurer of the Society on vouchers approved by the chairman of a committee.~~

Current Expenses.—Expenses for postage incurred in connection with the business of committees will be refunded by the Treasurer of the Society on vouchers approved by the chairmen of these committees.

Stationery.—Correspondence relating to the business of committees or sub-committees shall be conducted on official stationery which will be furnished by the Secretary of the Society.

Extraordinary Expenses.—Expenses for items other than stationery and postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of previous authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus collected shall be transmitted to the Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Treasurer of the Society. Payments for such purposes shall be made by the Treasurer of the Society only on vouchers approved by the chairman of the committee concerned.

Discharge of Committees.—Technical committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed or in consequence of protracted inactivity. A technical committee which fails to present a report at three successive annual meetings of the Society will be required to show cause, in a written communication to the Executive Committee, why it should not be discharged.

Technical committees may be discharged for cause by the Executive Committee at its own initiative.

[NOTE.—Subsequent to the presentation of the above report, additional regulations affecting the American representation on committees of The International Association for Testing Materials have been adopted by the Executive Committee, after reference to and approval of Committee E-5. These added regulations appear on pages 190-191 of the 1914 Membership Pamphlet and on pages 449–450 of the 1914 Year-Book.—ED.]

REPORT OF COMMITTEE E-6

ON

PAPERS AND PUBLICATIONS.

By authorization of the Executive Committee the designation of Committee E-6 on Papers has been changed to that of Committee E-6 on Papers and Publications.

Since the last annual meeting Committee E-6 has held one general meeting and its Advisory Committee has met twice. The Regulations Governing Papers, Committee Reports, and Discussions, which the committee announced in connection with its last annual report, have been adhered to with satisfactory results. As the terms of these regulations become better known to the members of the Society their observance will be correspondingly facilitated. The committee has agreed upon a few minor modifications in these regulations which, if approved by the Executive Committee, will appear in the revised regulations which will be published in the 1914 Year-Book.[1]

The committee has made extraordinary efforts to have all of the matter presented at this meeting preprinted and circulated in advance among the members of the Society at large. Of the 24 committee reports and 36 papers included in the final program for the annual meeting, 23 committee reports and all papers, totaling 928 pages, have been printed in advance of the meeting. With the exception of 2 committee reports and 10 papers, all of this printed matter has been distributed as part of three instalments of preprints, of which the first was issued four weeks, the second two weeks, and the third one week before the opening date of the meeting.

An innovation made this year, which it is believed will meet with favor, is the printing of a brief summary, not exceeding 300 words, in connection with each paper. These summaries will also be published in the Proceedings.

[1] Pp. 474–476.—Ed.

The committee has exercised its discretion, under the regulations, as to the rejection of papers received too late for advance printing. Only one committee has found it impracticable to have its report available sufficiently far in advance of the meeting to admit of preprinting. As stated in last year's report such exceptions are always to be expected unless the regulations are made more rigid than the committee deems advisable.

This report has been submitted to letter ballot of the committee which consists of 11 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

OFFICERS

OF THE

AMERICAN SOCIETY FOR TESTING MATERIALS.

President,

A. W. GIBBS

Vice-Presidents,

RICHARD MOLDENKE (*Term Expiring in 1915*)

A. A. STEVENSON (*Term Expiring in 1916*)

Secretary-Treasurer,

EDGAR MARBURG

Office: University of Pennsylvania, Philadelphia, Pa.

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JOHN BRUNNER
F. H. CLARK
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FINANCE COMMITTEE.

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F. H. CLARK
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